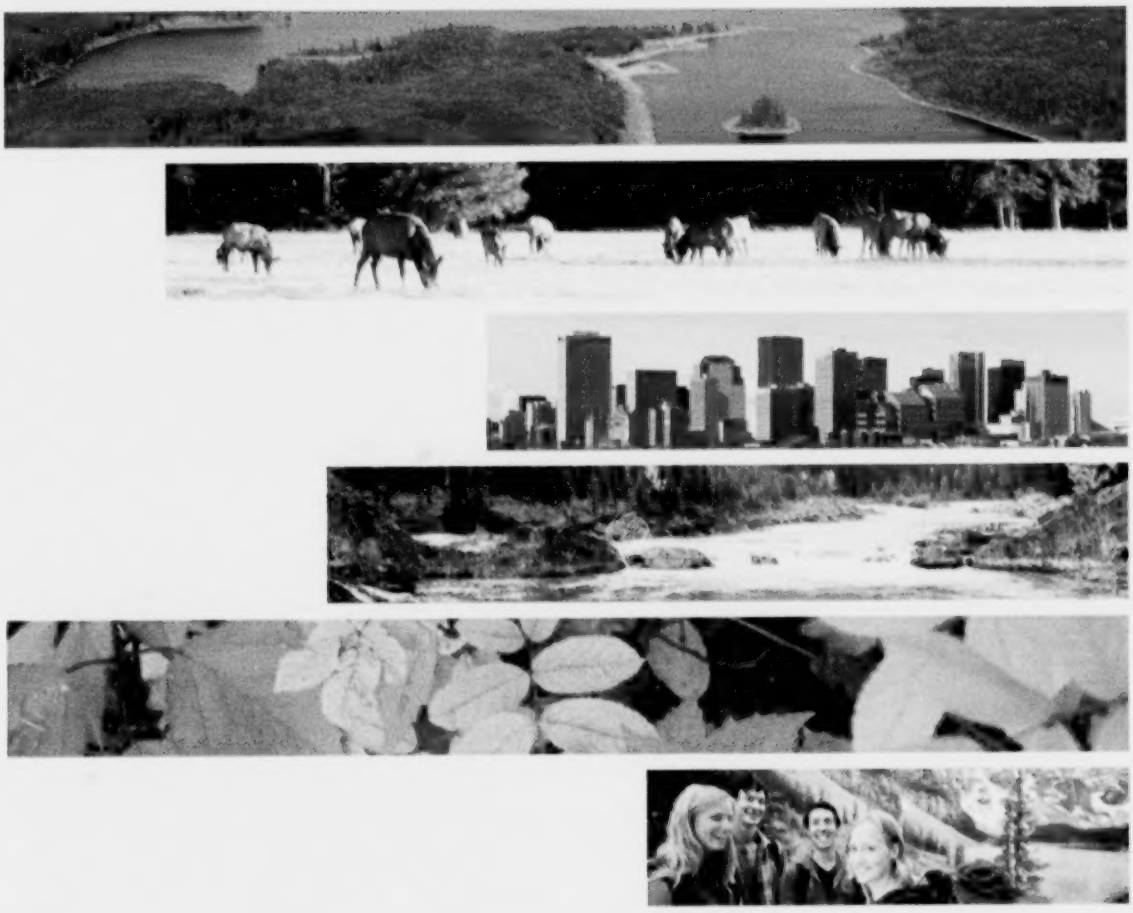
A World Class Environmental Monitoring, Evaluation and Reporting System for Alberta

The Report of the Alberta Environmental Monitoring Panel

June 2011



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Alberta Environmental Monitoring Panel

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June 30, 2011

The Honourable Rob Renner
Minister of Environment
#425 Legislature Building
10800 – 97th Avenue
Edmonton, AB T5K 2B6

Dear Minister Renner:

The Alberta Environmental Monitoring Panel has concluded its work and is pleased to present our final report and recommendations.

The Panel held public engagement sessions in Fort McMurray, Edmonton and Calgary and consulted directly with First Nations and Métis communities in the Lower Athabasca region. Written submissions were also received from interested individuals and organizations. The Panel was impressed by the quality of the input received. Albertans had strong opinions on the future direction of environmental monitoring and stressed the need for urgent action.

This report makes recommendations for the establishment of a world class environmental monitoring, evaluation and reporting system to be managed by Albertans for Alberta. A key recommendation is the creation of the Alberta Environmental Monitoring Commission to operate at arm's length from government, regulators and those being regulated. The Commission would be responsible for the strategic direction, scientific focus and on-going operation of the proposed environmental monitoring system.

As co-chairs, we look forward to discussing this Report with you at your earliest convenience.

Sincerely on behalf of the Panel

original signed

Hal Kvisle
co-chair

original signed

Howard E. Tennant
co-chair

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Monitoring Panel

Executive Summary

The appointment of the Alberta Environmental Monitoring Panel was announced in January 2011 by Hon. Rob Renner, Minister of Environment. The Minister's announcement directed this independent expert Panel to provide recommendations on the development of a provincial scale world class environmental monitoring, evaluation and reporting system, with an initial focus on the Lower Athabasca region in northeastern Alberta.

The Work of the Panel

The Panel began its work in February 2011, reviewing recent studies and reports and seeking information about environmental monitoring initiatives underway in Alberta and elsewhere. To more fully understand the needs and concerns of Albertans, panel members visited the oil sands region, held public engagement sessions in Fort McMurray, Edmonton and Calgary, met with aboriginal communities, and considered additional written submissions from the public and various stakeholders.

The Panel focused its efforts in three main areas:

- The science-based drivers of a successful monitoring and evaluation system.
- Acquisition, management, evaluation and dissemination of data and information.
- The organizational, governance and structural requirements of a world class environmental monitoring, evaluation and reporting system.

As requested by the Minister, this report presents the Panel's specific recommendations to guide the implementation of a province-wide, world class, science-based, environmental monitoring, evaluation and reporting system, the first phase of which we recommend be implemented in the Lower Athabasca region. The recommendations in this report have the full support of all Panel members.

What the Panel Learned

Environmental monitoring in Alberta currently consists of a collection of individual monitoring networks around the province that have differing objectives, governance and operational structures. These networks do not form an integrated system and are not optimally configured to support cumulative effects management or the environmental management frameworks associated with regional plans. Local and regional monitoring is being done throughout Alberta by various agencies

with considerable effort and financial resources expended to collect large amounts of data. However, recent studies have suggested that, at least in the Lower Athabasca region, new approaches are needed. These studies indicate that ongoing oil sands development will have material economic, environmental and social impacts within Alberta and across Canada and North America. The current and future development of world-scale resources in the oil sands region makes scientific, credible and transparent environmental monitoring an imperative for Alberta and Canada.

Monitoring, evaluation and reporting activities in the Lower Athabasca region have been closely scrutinized in several comprehensive reports commissioned by the federal government, the Alberta government and the Royal Society of Canada. The Federal Oil Sands Advisory Panel (2010) noted that current monitoring systems lack consistency and coordination, resulting in a limited capability to deliver data and information that is useful to decision makers. We took notice of the Federal Panel's recommendation that a monitoring system should be "founded on accepted scientific principles," and also the Royal Society's view that "The people of Alberta must be able to have confidence that such regulatory decisions are being made by highly skilled, senior technical specialists based strictly on the merits of scientific, technical, and economic evidence free of political interference."

What the Panel Recommends

The Panel reached three main conclusions, around which the recommendations in this report were developed:

- Alberta needs a new environmental monitoring, evaluation and reporting system that focuses on environmental effects monitoring, is grounded in rigorous scientific design and execution, incorporates Traditional Environmental Knowledge, and has a publicly accessible data and information management system.
- Environmental monitoring, evaluation and reporting activities must be organized and integrated across the province and across air, land, water and biodiversity to enable more effective use of funds and ensure a consistent approach.
- The best way to ensure scientific oversight and organization and integration of activities is to establish a permanent, sustainably-funded, arm's length Environmental Monitoring Commission.

The Panel recommends that an arm's length, science-based, transparent monitoring system for air, land, water and biodiversity be implemented for the Lower Athabasca region, to be extended in phases throughout the rest of Alberta. Implementation is a matter of some urgency, and will require extensive reorganization of existing monitoring programs in the province. This recommendation is consistent with the findings of several other reviews. We share the optimism of the Federal Panel that "the current activities could be transformed into a system that will provide credible data for decisions—a system that will... encourage the necessary foresight to prevent a compromised environment."

If properly implemented and expanded to include Traditional Environmental Knowledge, such improvements would deliver excellent environmental information and increase public confidence in Alberta's environmental management systems. The establishment of a province-wide monitoring, evaluation and reporting system, beginning with the Lower Athabasca region, will represent a world class initiative for Alberta. The Panel accepts the views of many Albertans who voiced their determination to advance responsible and innovative economic, social and environmental stewardship of our land, water and air. Science-based, coordinated, cost-effective and transparent environmental monitoring in Alberta can, and should, be achieved. The time to do it is now.

Recommendations

Recommendation 1: Comprehensive Environmental Monitoring System as a Pillar of Natural Resource Management in Alberta

The Panel recommends comprehensive environmental monitoring, evaluation and reporting as a fourth pillar of Alberta's natural resource management framework, alongside regional land use planning, an enhanced energy regulatory process and cumulative environmental effects management.

Recommendation 2: Expansion and Integration of Environmental Monitoring in Alberta

The Panel recommends that, to achieve a world class standard, Alberta a) expand its environmental monitoring activities to place a greater emphasis on baseline monitoring and environmental effects monitoring; b) integrate and organize environmental monitoring, evaluation and reporting activities; and c) facilitate effective flow of information between those responsible for baseline monitoring, compliance monitoring and effects monitoring activities, including compliance agencies and scientific experts.

Recommendation 3: Traditional Environmental Knowledge

The Panel recommends that mechanisms be established to ensure that Traditional Environmental Knowledge is respected and utilized in environmental monitoring, evaluation and reporting in all regions of Alberta.

Recommendation 4: Improving Federal and Provincial Environmental Coordination and Cooperation

The Panel recommends that Alberta take a lead role in clarifying the roles and responsibilities of Alberta and Canada with respect to environmental monitoring to achieve world class results that reflect scientific and operational excellence.

Recommendation 5: A New Monitoring, Evaluation and Reporting System for Alberta

The Panel recommends that a province-wide monitoring, evaluation and reporting system be organized on a regional basis, aligning with the boundaries described in the Alberta Land-use Framework. The new system would provide regional and province-wide information that is timely and useful to government, regulators, industry, researchers, stakeholders and the public.

Recommendation 6: Values and Principles

The Panel recommends that the following values and principles be adopted to guide the development and operations of the environmental monitoring, evaluation and reporting system:

LEGITIMACY: The environmental monitoring, evaluation and reporting system must be independent of government, industry and special interests.

CREDIBILITY: Science must drive the design, execution, evaluation and reporting of monitoring programs. Activities must be conducted in an open and transparent manner.

RELEVANCE: Information provided by the environmental monitoring, evaluation and reporting system must meet the needs of stakeholders.

OPERATIONAL EXCELLENCE: The environmental monitoring, evaluation and reporting system must demonstrate excellence in all aspects of field monitoring, evaluation and reporting.

Recommendation 7: Scientific Oversight and Rigor

The Panel recommends that science be the primary driver of the design and execution of monitoring, evaluation and reporting activities. All monitoring, evaluation and reporting activities must demonstrate scientific rigor and continually adapt to environmental change, local and regional needs, evolving scientific knowledge and advances in technology.

Recommendation 8: Data Management, Information and Reporting

The Panel recommends that Alberta's environmental monitoring, evaluation and reporting system include a coordinated, publicly accessible data management system for baseline monitoring data, compliance monitoring data and effects monitoring data, with protocols to ensure transparency in data collection, analysis, reporting, and conveyance to government.

Recommendation 9: The Alberta Environmental Monitoring Commission

The Panel recommends that Alberta establish the Alberta Environmental Monitoring Commission as a science-driven, arm's length, and operationally excellent public agency. The Commission would be responsible for baseline monitoring, effects monitoring and state of the environment monitoring in all regions of Alberta.

Recommendation 10: Commission Mandate

The Panel recommends that the Alberta Environmental Monitoring Commission:

a. Be responsible for field monitoring, data evaluation and reporting of environmental conditions, including baseline monitoring and effects monitoring for all regions of Alberta;

b. Be responsible for all aspects of environmental effects monitoring, whether field activities are conducted directly by the Commission or by other entities acting for the Commission. The quality and efficiency of all monitoring programs would be the responsibility of the Commission;

c. Where appropriate, assume direct responsibility and accountability for regional effects monitoring programs currently carried out by industry or by stakeholder organizations; and

d. Have access to all compliance monitoring data as input to its evaluation and reporting activities. The Commission could provide technical and scientific advice and assistance to government and regulators regarding the design and operations of compliance monitoring activities. However, the Commission would not be responsible for compliance enforcement.

Recommendation 11: Coordination with Alberta Government Ministries and Corporations

The Panel recommends that the Minister of Environment create a Monitoring Advisory Committee to coordinate cross-ministry interests.

Recommendation 12: Coordination with Other Teaching and Research Organizations

The Panel recommends that the Alberta Environmental Monitoring Commission coordinate its research-related activities with Alberta Advanced Education and Technology and Alberta's universities and colleges.

Recommendation 13: Governance Board

The Panel recommends that the Minister of Environment appoint a Board to govern the Commission. All Board members should be selected based on merit relevant to the Commission. The Board would be led by a Chair and Vice-Chair appointed by the Minister.

Recommendation 14: Interim Appointments

The Panel recommends that the Minister of Environment select an Interim Chair and Vice-Chair for the Commission, who would then consult with the Minister on the process of naming interim Board members. This is an urgent requirement and should be in place in a matter of months to expedite the transition from the current system.

Recommendation 15: Science Advisory Panel

The Panel recommends that the Commission appoint a Science Advisory Panel composed of internationally-recognized experts in environmental monitoring, evaluation and reporting to provide independent advice on the design, implementation and quality of the Commission's monitoring, evaluation and reporting activities.

Recommendation 16: Aboriginal Participation

The Panel recommends that the Commission establish a mechanism, in consultation with representatives from Treaties 6, 7 and 8 and the Métis Nation of Alberta, to enable aboriginal communities to develop a proposal for their participation in Commission activities, including community-based monitoring programs.

Recommendation 17: Stakeholder Input

The Panel recommends that the Commission establish mechanisms to encourage and facilitate stakeholder input to monitoring programs in each region as well as at the provincial level.

Recommendation 18: Funding the New Environmental Monitoring System

The Panel recommends that a dedicated and sustainable funding model be established to support the work of the Commission. Alberta should use its legislative authority and negotiating power to determine which parties should share the cost of implementing the required monitoring, evaluation and reporting system.

Recommendation 19: Assessment of Existing Environmental Monitoring Activities

The Panel recommends that the interim Board of the Commission complete, as an early priority, an assessment of all existing monitoring programs in Alberta with a view to developing a strategy for the integration of existing monitoring programs into the work of the Commission, as appropriate.

Recommendation 20: Phased Implementation

The Panel recommends that the new monitoring, evaluation and reporting program be implemented first in the Lower Athabasca region, and then implemented in phases throughout the rest of Alberta.

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Introduction

1

1.1 The Geo-Political Context

In 1905, the new Province of Alberta assumed control of a vast territory almost as large as France. Alberta was largely undeveloped in 1905, with pristine prairies, forests, air and water. Subsequent growth in urban centers and rural towns and in agriculture, forestry and mining accelerated in the late 1940s with the discovery of major oil and gas deposits.

Natural resources have been the engine of Alberta's economy for over a century, delivering prosperity that has attracted people and investment from around the world. This economic success has built a dynamic and vibrant society with a high quality of life for most residents. Although many sectors, such as agriculture, forestry and tourism, have contributed to this success, Alberta's energy resources have been and continue to be the primary economic driver.

The pace of economic development, including but not limited to the energy sector, is placing extraordinary pressures on the province's natural environment. While many other jurisdictions experience similar economic and social pressures, Alberta has been in the global spotlight, with growing attention on our resource development policies, particularly related to oil sands development. Increasing resource extraction activities—in the energy sector as well as other resource-based industries—will exert more and more pressure on Alberta's environment, intensifying the focus on how we manage our air, land, water, and biodiversity. Investment in the energy sector, especially the oil sands, is forecast to grow substantially. The world wants and needs Alberta's energy resources, and Alberta has an established and enviable reputation as a politically secure and stable energy producer, which has attracted global investment interest. Asian economies are using more energy while several regions that traditionally supplied much of the world's fossil fuels are experiencing political changes. Understandably, Canada's major trading partner, the United States, is seeking to secure sustainable, long-term energy supplies.

The Lower Athabasca and Cold Lake regions contain approximately 81% of Alberta's bitumen reserves. Using current technology, it is estimated that about 175 billion barrels of bitumen, or 10% of the entire estimated Alberta oil sands resource, can be recovered economically. Future advancements could lead to development of the full 1.71 trillion barrels of bitumen (Government of Alberta, 2011b). Investment

in the oil sands has increased dramatically over the past two decades, from $490 million in 1991 to a high of over $20 billion in 2008, prior to the global recession (Government of Alberta, 2011b). The Canadian Energy Research Institute (Millington and Mei, 2011) projects that, over 35 years, total capital investment in oil sands could range from $213 billion to $302 billion, during which time natural gas requirements could rise by two to three times current levels. During this same period, CERI projects that emission compliance costs to the oil sands industry could reach $142 billion. Another CERI report (Honarvar *et al.*, 2011) estimates a total GDP impact of $2.1 trillion for Canada and more than $500 billion for the United States. Employment in Canada (direct, indirect, and induced) as a result of new oil sands investment is predicted to grow from 75,000 jobs in 2010 to 905,000 jobs in 2035.

These circumstances will intensify pressure on Alberta to become a better environmental steward, with the most acute focus on the Lower Athabasca region. Other regions in southern and central Alberta are also under stress, particularly with respect to water. These pressures in the south are so severe that the South Saskatchewan River Basin is closed to new water license applications. The challenge is provincial in scope.

Alberta has an opportunity to reflect on its economic, social and environmental values and consider how its air, land, water and biodiversity should be conserved and managed for future generations. The challenge will be to ensure that development takes environmental, social and economic considerations into account. Many people in Alberta and elsewhere have expressed concerns and opinions about how to achieve enhanced environmental protection. Investment institutions are also increasingly aware that the environmental and social impacts of oil sands development could pose risks to the long-term value of the companies involved and create uncertainty for investors. Alberta needs to understand, acknowledge and mitigate these impacts for the benefit of everyone. An urgent first step is to design and establish an effective and credible environmental monitoring, evaluation and reporting system.

1.2 The Alberta Environmental Monitoring Panel

In January 2011, Hon. Rob Renner, Minister of Environment for the Government of Alberta, announced the appointment of the Alberta Environmental Monitoring Panel (the Panel). The Panel's mandate was to provide recommendations on a framework and guiding principles for the development, implementation and sustainment of a world class environmental monitoring evaluation and reporting system for the province of Alberta. The appointed members (Appendix A) bring a wide range of experience and expertise to the Panel.[1]

[1] The Panel's terms of reference also appear in Appendix A.

Minister Renner's announcement of this independent expert Panel followed the publication of several reports on the environmental impacts of oil sands developments.[1] The Panel began its work in February 2011 by reviewing recent studies and reports and learning about monitoring initiatives already underway in Alberta and elsewhere. To better understand the needs and concerns of Albertans, the Panel visited the oil sands region and held three days of engagement sessions in Fort McMurray. Engagement sessions were also held in Edmonton and Calgary and written submissions were invited and received.

The Panel focused its efforts in three main areas:

- The science-based drivers of a successful monitoring and evaluation system.
- Acquisition, management, evaluation and dissemination of data and information.
- The organizational, governance and structural requirements of a world class environmental monitoring, evaluation and reporting system.

1.3 Policy Context for the Panel's Work

The Government of Alberta has updated its natural resource development policy framework by advancing three specific initiatives, intended to produce a comprehensive and integrated strategy to manage resource development and maintain a high standard of environmental stewardship across the province:

- The Land-use Framework and development of regional land use plans under the *Alberta Land Stewardship Act*;
- A shift to cumulative effects management; and
- Establishment of a single regulatory body for the upstream oil and gas industry, as proposed by Alberta's Regulatory Enhancement Task Force (2010).

These policy initiatives provided important context for the Panel's work and are described more fully in Appendix B.

The Land-use Framework calls for the government to establish seven new land use regions and develop a regional plan for each. These regions are based on major watersheds with their boundaries adjusted to align with municipal boundaries (Government of Alberta, 2008). The Panel supports the use of these land use regions as the basis for the new environmental monitoring, evaluation and reporting system recommended in this report, noting that in some cases, regions could be combined

[1] These reports are included in the Bibliography.

for environmental monitoring purposes. Although the need for such a system is most pressing in the Lower Athabasca region, all of Alberta would benefit. High quality environmental effects data are needed to develop and implement regional land use plans and to support cumulative effects management.

Cumulative effects management shifts the regulatory focus from mitigating project-specific impacts to achieving integrated environmental outcomes that take into account air, land, water and biodiversity, as well as social and economic considerations. These outcomes will be expressed through regional plans and other provincial policy instruments such as the development of regional thresholds with triggers and limits. The achievement of cumulative effects management outcomes will need to be validated by data and information produced by an integrated environmental monitoring, evaluation and reporting system.

The third policy initiative is the establishment of a single regulatory body with unified responsibility for upstream oil and gas development activities. This "single regulator" would simplify the existing process and bring greater regulatory expertise to bear by providing a "one-window" approach for the assessment and approval of development applications.

The Panel was sensitive to the need to ensure its work reflected current policy directions of the Government of Alberta in the areas of land use planning, energy regulation and cumulative effects management. The Panel commends the Government of Alberta for its strategic application of these policies and initiatives on a province-wide scale. At the same time, a credible and trusted environmental monitoring, evaluation and reporting system is essential for good natural resource management and is an important policy gap that is addressed by this report. The Panel is of the view that the environmental monitoring, evaluation and reporting system should be viewed as the fourth key policy initiative in the Government of Alberta's efforts towards a comprehensive natural resource development strategy.

Recommendation 1:

Comprehensive Environmental Monitoring System as a Pillar of Natural Resource Management in Alberta

The Panel recommends comprehensive environmental monitoring, evaluation and reporting as a fourth pillar of Alberta's natural resource management framework, alongside regional land use planning, an enhanced energy regulatory process and cumulative environmental effects management.

1.4 What Albertans Said

Listening to what Albertans had to say about environmental monitoring was an important part of the Panel's work. The Panel heard from many Albertans at public and aboriginal engagement sessions and through written submissions (see Appendix C). The Panel was impressed by the breadth and quality of the input received and found that Albertans were passionate about the environment. They had strong opinions on the future direction of monitoring and stressed the need for urgent action to establish a comprehensive environmental monitoring, evaluation and reporting system for the province.

The Panel asked stakeholders and the public to consider five key questions:

1. What should a world class environmental monitoring system look like?
2. What type of organization should manage and operate the proposed environmental monitoring system?
3. What kind of information should the environmental monitoring system produce?
4. How should the environmental monitoring system be funded?
5. Do you have any further suggestions or advice to help the Panel as they develop recommendations for a world class environmental monitoring system?

Thirty-one organizations and individuals presented material in person or via the project website. The Panel received many thoughtful submissions, a number of which were based on experience with current environmental monitoring systems in Alberta. This input was helpful and the Panel's report reflects the direction given in these submissions.

1. What should a world class environmental monitoring system look like?

Most presentations used the words "credible" and "transparent" in describing the key attributes of a world class environmental monitoring system. An essential element of credibility is that the output of the monitoring system (data and reports) can withstand review and scrutiny by independent scientists. Stakeholders said that science needs to permeate all aspects of the monitoring, evaluation and reporting system to deliver the best possible information and build trust and confidence in that information. As one speaker noted, "You can't manage what you don't understand. Science is the driver behind a credible monitoring program." Several presenters spoke of the need for a monitoring system that looks holistically at air, land, water and biodiversity, with strong linkages to research programs. This implies a monitoring system that is adaptive and responsive.

Many presenters suggested specific components that should be monitored. A consistent message was that Alberta needs a comprehensive, integrated, state-of-the-art monitoring system that can assess cumulative effects. Such a system must be able to monitor regional stressors. Aboriginal representatives recommended community-based monitoring to take advantage of local expertise, particularly Traditional Environmental Knowledge. Better collaboration and cooperation between the governments of Alberta and Canada were often noted as essential for the success of a world class monitoring system in the province.

2. What type of organization should manage and operate the proposed environmental monitoring system?

"Independence" was the word most often used by presenters in describing the type of organization that should manage and operate a new environmental monitoring system. Independence means a system that is at arm's length from government, industry and special interests to avoid perceptions of conflict of interest. Many speakers told the Panel the organization should have the appropriate level of responsibility, authority and resources to implement a comprehensive, province-wide environmental monitoring program.

Presenters spoke of the need for strong scientific leadership and several of them specifically recommended a science oversight committee with international experts. Others noted that operations and management expertise is as important as science oversight, and that an interdisciplinary approach is needed. It was also suggested that regional and aboriginal advisory panels should be part of the organizational structure to provide local and regional advice and guidance on incorporating Traditional Environmental Knowledge.

3. What kind of information should the environmental monitoring system produce?

The Panel consistently heard that data produced by the system must be made available in a manner that is open, widely accessible, timely, and preferably free. Many speakers noted the need for an electronic reporting system with standardized protocols for data collection, formatting, presentation and access. People want data to be made available in formats that are easy to understand and use. An online data repository that could be accessed by stakeholders, researchers and the public was recommended.

Several speakers suggested that there is a need to make better use of data collected through existing compliance monitoring programs, with a view to integrating these data with other monitoring data. Monitoring data and results of specific monitoring programs should be regularly compiled and published. Data related to Traditional Environmental Knowledge should also be reflected in reports and information produced by the monitoring system.

4. How should the environmental monitoring system be funded?

The Panel heard that a stable, secure, long-term funding mechanism is critical to the success of the new monitoring system and the organization that will oversee it. More than one speaker commented that substantial funding now flows to numerous monitoring programs and these funds could be re-allocated for more effective use. It was also pointed out that a substantial amount of existing capital equipment could be reconfigured to fit the needs of the new system. Presenters who commented on this question generally believed that the Government of Alberta should be responsible for funding through a "polluter pay" system. One presenter stressed that a "polluter pay" mechanism should include charges for pollution from both point and non-point sources.

Cooperative funding arrangements with other levels of government and with industry should also be explored. Other potential revenue sources include fees attached to commodities such as fuel or emissions such as carbon dioxide. There could also be opportunities for a new monitoring agency to undertake fee-for-service work for clients that want more complex and specialized data analysis.

5. Other suggestions and advice

Presenters noted that good environmental monitoring is being done by some organizations and that work should continue; however, large gaps in data and knowledge remain. The Panel was asked to consider how data and information produced by existing organizations could be used by a central organization that would have the resources to oversee the integration necessary for a world class system. Presenters also mentioned the need to examine existing programs with a view to eliminating redundancy and making more efficient use of limited resources.

Presenters in the Lower Athabasca region spoke about their health concerns related to air and water quality. Aboriginal participants believe the current system is not capable of responding to perceived health risks posed by odors; water contamination and low water levels in rivers; and impacts on wildlife habitat, drinking water, and

berries. They stressed the need for community involvement in monitoring, noting that community members could gather data based on traditional knowledge and employ traditional techniques to identify environmental changes. Aboriginal communities also spoke of the need for a regional monitoring system that can respond quickly to local incidents, odors, spills and upsets.

A few participants spoke of the opportunity for a new monitoring agency to take advantage of social networking tools to inform citizens about monitoring.

Most stakeholders wanted some level of involvement in the new monitoring system – at the design stage, as participants on advisory committees, or at the implementation stage through participation in regional or community level activities.

Environmental Monitoring, Evaluation and Reporting

2

2.1 Factors Affecting the Condition of Alberta's Environment

All human activities have a potential impact on the landscape. Industries, including energy, agriculture, forestry, power generation, utilities, mining, petrochemicals and tourism, as well as urban growth and transportation each have the potential to affect air, land, water and biodiversity. The potential environmental impacts of these activities must all be measured, evaluated and managed.

Population growth is a major driver of environmental impact. Alberta Finance and Enterprise (2011a) projects that Alberta's population will grow to 6.0 million by 2050, a 62% increase from the current 3.7 million. In this "medium scenario," the population in five census divisions (Calgary, Medicine Hat, Red Deer, Wood Buffalo, Grande Prairie) is expected to grow faster than the provincial average.

Human development activities create stresses on Alberta's environment that vary across the province (see Appendix B). In southern Alberta, water availability is already a challenge and the South Saskatchewan River Basin is closed to new water license applications. Despite improvements in efficiency, demands from municipalities, irrigation, intensive livestock operations and other water users are likely to maintain stress on both water quantity and quality. Alberta also has legal requirements with respect to the volume of surface water that it must pass on to downstream jurisdictions.

Across central Alberta, activities with potential for environmental impacts include conventional oil and gas development, coalbed methane activities, hydrocarbon processing and petrochemical industries, agriculture, and forestry. Forestry and pulp and paper are important activities in northwest Alberta, along with mining, pipelines and conventional oil and gas. Oil sands activities predominate in northeastern Alberta, but agriculture, forestry and natural gas are also present and can have environmental impacts.

Pollution of air, land and water cannot be considered as separate, isolated problems. These systems are interconnected and must be examined holistically if we are to understand and manage cumulative effects. As an example, airborne pollution can potentially contribute contaminants to the surface water system, much of this from

the snowpack. In addition to better monitoring of air, land and water, there is a need to further evaluate the input of pollutants to the landscape and their movement between air, land and water systems using mass balance principles and transport models.

It is clear that expanded baseline monitoring and rigorous environmental effects monitoring are priorities in most regions of Alberta. The Panel expects that a new provincial monitoring system, with advice from scientists, will examine Alberta's environment in greater detail and determine the best way to ensure that current and emerging issues receive the attention they need.

Alberta's air quality is influenced primarily by emissions from urban centers, transportation, and industrial, agricultural and other development activities. These emissions contribute to acid deposition and smog, and many add greenhouse gases to the atmosphere. Some substances regarded as pollutants also have natural sources, such as carbon monoxide, particulate matter and volatile organic compounds released from forest fires. Odors also affect air quality and occur most often near energy facilities and intensive livestock operations. In the Lower Athabasca region, local odor problems occur at Fort McKay and in the vicinity of industrial operations due to release of reduced sulphur compounds and hydrocarbons. Oil sands activities are an increasing source of airborne contaminants, as industry's own reporting to the National Pollutant Release Inventory indicates.

Land and soil are repositories for both air and water pollution. Dry deposition of acidifying compounds, such as sulphur oxides and nitrogen oxides mainly from air emissions, can affect sensitive soils, crops, and natural vegetation, including forests. The application of pesticides and fertilizers by rural and urban users can affect both soil and water. Reclamation is an important issue for coal mines, oil sands, oil and gas wells, and abandoned industrial sites. In the oil sands and other mining regions, substantial reclamation efforts will be needed for both tailings ponds and mine sites.

Alberta's water resources include both surface and groundwater. Understanding their quantity and quality is necessary for good resource management. Many sectors use water, both consumptively and non-consumptively, for residential, commercial, industrial, agricultural and recreational purposes.

Surface water quantity varies substantially from year to year, with major impacts on water users and the environment. Central and southern Albertans—roughly 88% of the province's population—rely on just 13% of Alberta's surface water supply found in the North and South Saskatchewan River basins. Water quality is affected by natural conditions and human activities. Sources of surface water contamination include regulated point sources (e.g., municipal sewage treatment facilities) and non-point sources such as runoff from farms (manure, pesticides and fertilizers) as well

as municipal stormwater runoff. Specific surface water concerns have arisen in the Lower Athabasca region, relating to the cumulative effects of industrial pollution and the potential impacts of certain metals and hydrocarbons. Concerns also exist about the environmental effects of changes associated with water usage and river flows.

Most rural Albertans as well as those in many towns and villages rely on groundwater for their household water supply. Agriculture and some industrial sectors also use groundwater to support their operations. Much of Alberta's groundwater is saline, which constrains its uses. About 3% of water licenses in Alberta are for groundwater use, but this number is expected to grow as surface water becomes less available, especially in southern Alberta. Landfills, fertilizer use and underground fuel tanks are examples of activities that can negatively affect groundwater quality. Poorly installed well casings on domestic water wells and oil and gas wells can also affect groundwater quality. The effects of large-scale disturbances on regional deep and shallow groundwater systems are poorly understood. In the Lower Athabasca region, this is compounded by uncertainties and a limited understanding of regional oil sands hydrogeology.

Alberta uses the Canadian Biodiversity Strategy as a guide for conserving biodiversity and ensuring the sustainable use of biological resources. The most commonly referenced types of biodiversity are genetic diversity, species diversity, and ecosystem diversity. Alberta uses the percentage of species at risk and the status of Alberta species as indicators of biodiversity condition. Habitat disruption and fragmentation due to multiple development projects, including urban development, can have a major impact on plant and animal species. Aquatic species can be threatened by reduced water quality and quantity and by habitat loss; examples include loss of spawning areas due to siltation, lack of oxygen due to an influx of nutrients, warming of water due to loss of riparian vegetation, reduced winter water levels that can cause a water body to freeze more deeply, and other factors.

2.2 The Value of Environmental Monitoring, Evaluation and Reporting

Environmental monitoring has many facets and the technical language used to describe it can be confusing. The situation is further complicated by the fact that we are interested in monitoring air, land, water and biodiversity within diverse geographic regions of Alberta.

A robust and trustworthy environmental monitoring system consists of three distinct components: monitoring, evaluation and reporting. Monitoring by itself is not sufficient. Integration of these components is essential for Alberta to manage

development while maintaining a high standard of environmental stewardship. This section expands on the three components and describes the important role played by science in environmental monitoring.

"Monitoring" uses a variety of techniques to sample air, water, soil, vegetation, fish and wildlife. The resulting data enable us to assess current environmental conditions and detect changes or trends. These data also enable analysis of the pressures that influence environmental conditions and the impact of management actions that are taken to correct or improve these conditions. Monitoring data are a cornerstone of a system that enables us to build environmental knowledge and assess environmental performance. A dynamic monitoring system has feedback loops that enable us to also monitor whether management actions are having the desired effect.

"Evaluation" involves assessing the monitoring data to determine what is happening to the environment and why. Integrated environmental assessments require scientific expertise from a variety of disciplines. Evaluation seeks to determine the existence and significance of relationships between emissions to and disturbances of the environment and the impacts those emissions and disturbances may be having on the environment. Cause-and-effect relationships are often complex and evaluation activities must take into account uncertainties in order to reveal problems that must be addressed. Evaluation work can also serve to refute environmental concerns where there is little or no cause and effect. The evaluation process can be extremely challenging scientifically and requires careful integration of scientific insight, statistical analysis, treatment of uncertainty, and process-based modeling. Monitoring data are needed across a range of spatial scales to support innovative analysis.

"Reporting" is the dissemination and publication of monitoring data and evaluation results to a variety of audiences. Environmental reports will inform governments, regulators, industrial operators, researchers and the public. Reporting promotes understanding of existing conditions, trends and potential risks; the pressures that affect these conditions; and potential management responses to reduce pressures and improve conditions. A key objective of environmental reporting is to communicate information that supports policy development and informs environmental management decision making.

Although many techniques can be used and monitoring is done for various purposes, the Panel focused on three categories of environmental monitoring: baseline monitoring, compliance monitoring and effects monitoring. Alberta has a long history of extensive compliance monitoring, but effects monitoring is less well developed and, like many jurisdictions, baseline monitoring is often overlooked in spite of its importance.

BASELINE MONITORING, as used in this report, describes the state of the environment and its natural variability. It quantifies background levels of physical and chemical parameters at locations that are least developed or ideally "non-impacted" by anthropogenic disturbance so that environmental changes can be measured. Baseline monitoring establishes the benchmark against which sites that are affected by development can be compared. It is important to continuously monitor the state of the natural environment to understand natural variability and change. Some baseline data are also needed for operational management; for example, data on river flows and lake levels are needed for water resource management and flood warning.

Where directly observed baseline data are uncertain or limited, as in the case of the Athabasca River, a special focus may be needed on the reconstruction of baseline conditions using surrogate data, including Traditional Environmental Knowledge. Finding suitable control areas and determining the reference point for the baseline will remain a challenge, especially in areas that are already experiencing development. As well, there are gaps in data on water use, which constrains potential management options. Licensed amounts are known, but often the full allocation is not used. Recently, a mechanism was put in place to enable irrigators in the Milk River Basin to send telemetered data to a central web site where water use could be more accurately monitored; other such innovative approaches could be valuable additions to baseline monitoring activities.

COMPLIANCE MONITORING, as used in this report, describes monitoring activities undertaken to determine if a particular facility is complying with its operating approval(s) and related licensing or permitting conditions. Compliance monitoring focuses on actions and activities. It requires data collection and analysis directly related to the regulated operation and is one of the most important elements of an environmental enforcement program. The data and information generated through compliance monitoring must be reliable and trustworthy. Compliance monitoring is used to:

- Detect and correct violations;
- Provide evidence to support enforcement actions; and
- Establish compliance status and determine if additional actions are required.

EFFECTS MONITORING, as used in this report, describes monitoring activities undertaken to determine the status or trend of specific environmental attributes or indicators that reflect the current state of the environment. Simply, effects monitoring focuses on changes in the environment resulting from various anthropogenic activities. Effects due to natural changes can also be observed.

Effects monitoring is used to:

- Provide information to support changes in regional, provincial or federal environmental policy;
- Provide information for long-term environmental planning;
- Determine progress towards policy and planning objectives;
- Detect unexpected or more severe than expected environmental changes;
- Understand the relationship between human stressors and environmental conditions;
- Generate applied research hypotheses; and
- Communicate the state of the environment to the public and interested stakeholders.

With the policy shift in Alberta to cumulative effects management, effects monitoring will become increasingly important to manage changes related to development. Cumulative effects monitoring and management rely on a sound assessment of baseline and current conditions. A new monitoring, evaluation and reporting system must expand its focus on baseline monitoring and effects monitoring to support the assessment of cumulative effects.

High-quality science provides a foundation for and plays a key role in all three types of monitoring activities. Monitoring techniques, technologies, approaches and analyses must demonstrate scientific rigor if the resulting information is to be of value. A mature monitoring program needs to test underlying assumptions, focus attention on high risk issues, examine the effects of specific management options, and develop links between the activity or implemented action and the effect.

World class monitoring requires world class science. The scientific process involves: observation, formulation of a hypothesis, making predictions based on the hypothesis, testing for the predictions, analysis, follow-up, re-evaluation, new observation, and so on. Key components of the practice of world class science include:

- Scientists trained in methods of observation and inquiry. In the modern world, the system of graduate education that leads to the doctoral degree (Ph.D.) has been designed to generate such individuals. Increasingly, post-doctoral experience under high level academic supervision is required before an individual is considered suitable to take a scientific leadership role.
- Complex science commonly requires complex instrumentation, and it is normal for such equipment to be maintained and operated by technical staff who may not require the same advanced level of training. However, continual supervision and oversight by the qualified scientist is always necessary to ensure consistent results.

- It is an essential part of the process of science for scientists to consult freely and widely with peers, colleagues and specialists outside their immediate circle. This ensures the maintenance of high standards and also ensures that the scientist is in touch with the latest developments in his/her field, which improves the efficiency, productivity, accuracy or relevance of the results being generated. Peer-reviewed publications are part of this process, and result in the science being fully transparent.
- Science intended to address the unknown cannot be bought "off the shelf" or outsourced.

Figure 1 illustrates how scientific monitoring should be carried out, in practice.

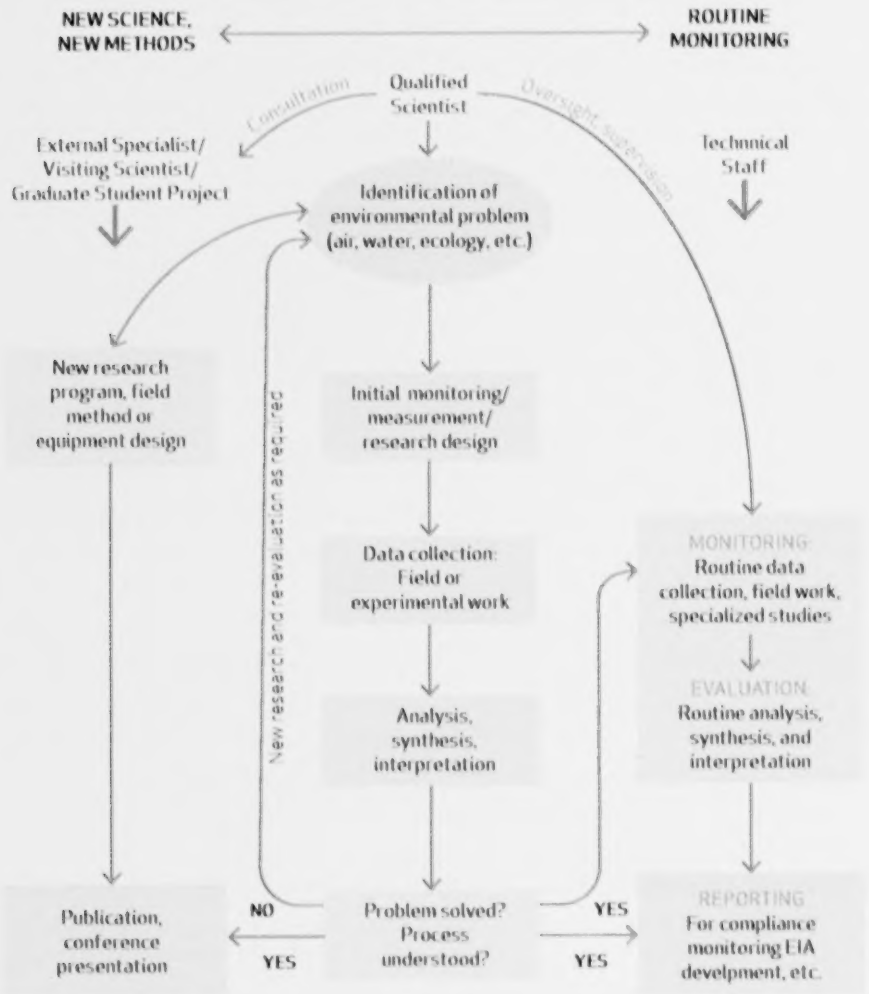
NEW SCIENCE, NEW METHODS
ROUTINE MONITORING
Consultation
Qualified Scientist
Oversight, supervision
External Specialist/ Visiting Scientist/ Graduate Student Project
Technical Staff
Identification of environmental problem (air, water, ecology, etc.)
New research program, field method or equipment design
Initial monitoring/ measurement/ research design
New research and evaluation as required
Data collection: Field or experimental work
MONITORING: Routine data collection, field work, specialized studies
Analysis, synthesis, interpretation
EVALUATION: Routine analysis, synthesis, and interpretation
Publication, conference presentation
NO
YES
Problem solved? Process understood?
YES
YES
REPORTING: For compliance monitoring EIA development, etc.

FIGURE 1. *The role of science in environmental monitoring*

The key person in this structure is the qualified scientist, who typically will hold a Ph.D. in a relevant discipline. The process of science is shown in the column of boxes running down the center of the diagram: the identification of a problem or topic to be studied, field observation, analysis, synthesis and interpretation. Further research and analysis may be required to improve the focus or the method or to revise working hypotheses. These procedures, which are ongoing and iterative, may be aided by the involvement of outside specialists, as shown on the left side of the diagram. They may assist with the design of new equipment or methods. New projects may also be designed for graduate or post-doctoral students, particularly where ongoing monitoring raises important new theoretical or practical problems.

The monitoring, evaluation and reporting process, as shown on the right side of the diagram, is the practical outcome of the work. While much of this is routine, it requires ongoing oversight and supervision by qualified scientists, especially where existing methods and procedures prove to be inadequate to the task at hand. The value of the involvement of the trained and experienced scientist in the adjustment and refinement of monitoring methods then becomes apparent. As the work proceeds, the completion of basic projects and the refinement of methods will typically provide the basis for the team to address new problems or to generate new means to evaluate old issues. Continuous interaction with the wider world of science, therefore, is essential to the monitoring process.

An integrated monitoring program requires collaboration between the scientific and regulatory communities and will seek to identify links between different types of monitoring. These links can increase the quality of monitoring and its ability to detect important trends, changes and interactions. Potential conflicts of interest must also be identified to ensure the program is genuinely independent and free from bias.

The value of operating in an open, transparent manner using the best available methods is that the outcome should earn widespread acceptance. The narrative then is not how government or industry is managing the message, but the practical issue of the nature of environmental effects and how to manage, mitigate or repair them. Industry and government regulators can turn to practical matters, secure in the knowledge that they are acting on the best available information.

Because of the legal nature of compliance requirements, compliance monitoring must be administratively controlled by regulatory agencies and therefore should be distinct from and independent of baseline monitoring and effects monitoring. This can be addressed by having an arm's length organization conduct province-wide

baseline monitoring and effects monitoring, while leaving formal responsibility for compliance monitoring and enforcement to existing regulatory agencies. The effects monitoring organization could be called upon to provide scientific advice and operational assistance to compliance regulators, ensuring that compliance programs are both effective and consistent with advancements in monitoring science.

The organization responsible for baseline monitoring and effects monitoring should have access to compliance monitoring data, enabling the integration of data and information arising from both compliance monitoring and effects monitoring programs. Both compliance monitoring and effects monitoring programs would be influenced and informed by regulatory and policy needs. Conversely, regulatory requirements and decisions should be informed by scientific effects monitoring advice, which identifies and describes potential impacts.

In summary, a world class monitoring system for Alberta must include baseline monitoring, compliance monitoring and effects monitoring. This requires a commitment to: 1) comprehensive and scientifically sound baseline monitoring; 2) compliance monitoring activities that are subject to rigorous oversight by provincial regulators; 3) effects monitoring that is coordinated, long-term, stable, and province-wide; and 4) applied research and/or specialized monitoring to answer specific short-term and long-term priority management questions. Opportunities to harmonize or leverage effects monitoring and compliance monitoring should be evaluated as part of the detailed planning of a comprehensive science-based environmental monitoring, evaluation and reporting system.

Recommendation 2:

Expansion and Integration of Environmental Monitoring in Alberta

The Panel recommends that, to achieve a world class standard, Alberta a) expand its environmental monitoring activities to place a greater emphasis on baseline monitoring and environmental effects monitoring; b) integrate and organize environmental monitoring, evaluation and reporting activities; and c) facilitate effective flow of information between those responsible for baseline monitoring, compliance monitoring and effects monitoring activities, including compliance agencies and scientific experts.

2.3 Traditional Environmental Knowledge

Traditional Environmental Knowledge (TEK) refers to the accumulated expertise and knowledge that aboriginal peoples hold about wild species and the environment in the area in which they live, together with the system in which that knowledge is obtained and modified over time. Since aboriginal peoples obtain their food, air and water from their land, and do not consider moving to be a viable option, they are particularly vulnerable to environmental degradation, and thus depend acutely on their accumulated knowledge and the systems through which they track changes in their environment.

The Panel's engagement sessions with the Fort McKay, Mikisew Cree, and Athabasca Chipewyan First Nations and with Métis representatives uniformly revealed their keen desire to be empowered to participate actively in environmental monitoring activities on their own terms. All groups held a deep respect for some western scientists with whom they have interacted over time. Based in part on this relationship, they are willing to engage in collaborative research projects that use western science techniques alongside TEK techniques to monitor and evaluate the health of fish, game, berries, air, land and water. They also support augmenting their traditional environmental knowledge with chemical analyses; for example, such analysis could help determine if contaminants in wild species make this food unsafe for human consumption. First Nations representatives reminded the Panel that their ability to live off their land by fishing, hunting and trapping is recognized in their treaties with Canada.

Broad-based efforts are being made in many parts of the world to recognize and incorporate Traditional Environmental Knowledge into environmental assessments and decision making. Examples include approaches taken by the Northern River Basins Study Board in Alberta and the work of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Much of TEK is grounded in observations that pertain directly to survival on the land. In many cases, TEK is compatible with western science approaches. For example, the Mikisew Cree have established measurable river base flow thresholds, based primarily on the ability to navigate their boats along the rivers to and from hunting grounds. To the extent that TEK systems depend on empirical data, there is considerable scope for collaborative research to address gaps in environmental knowledge. The groups also share a concept of a holistic environment that is compatible with the western concept of an ecosystem wherein everything works together to sustain life, and everything affects everything else.

Recommendation 3:

Traditional Environmental Knowledge

The Panel recommends that mechanisms be established to ensure that Traditional Environmental Knowledge is respected and utilized in environmental monitoring, evaluation and reporting in all regions of Alberta.

2.4 Federal-Provincial Coordination

Recent reports examining environmental issues in the oil sands region have noted the opportunity for federal-provincial cooperation and coordination in a new monitoring system. Collaboration and coordination with other regions and jurisdictions will be needed to the extent that impacts from development in Alberta are felt beyond provincial boundaries. Examples of areas of provincial and federal responsibilities for environmental management are shown in Figure 2, along with examples of federal-provincial cooperation.

Canada
Alberta
Canada:
› First Nations
› Federal Lands, national parks
› Transboundary air and water issues
› Deposition of deleterious substances (fisheries)
Alberta:
› Ownership of resources
› Environmental impact assessments
› Resource extraction licensing
› Setting environmental quality standards
Federal - provincial cooperation:
› Hydrometric network
› Northern River Basins Study (1996)
› Alberta Oil Sands Environmental Research (1975)
› National Air Pollution Surveillance Program
› Joint environmental assessment reviews

FIGURE 2: *Examples of areas of provincial responsibility, areas of federal responsibility and areas of federal-provincial cooperation for environmental management*

Alberta and Canada have an extensive history of coordination and cooperation on environmental matters. Examples include joint environmental impact assessments associated with major projects such as the Alberta Pacific Pulp Mill Project, the OSLO Project, and the Kearl Lake Project. These environmental assessments grew into cooperative federal-provincial efforts consistent with federal legislation under the *Canadian Environmental Assessment Act*, provincial legislation under the *Environmental Protection and Enhancement Act*, the *Canada-Alberta Agreement on Environmental Assessment Cooperation* and the *Canada-Wide Accord on Environmental Harmonization*. Other examples of inter-jurisdictional cooperation include baseline studies such as the Northern River Basins Study (1996) and the earlier Alberta Oil Sands Environmental Research Program that was initiated between Canada and Alberta (1975-1980). The Federal-Provincial Hydrometric Agreement between the Water Survey of Canada and Alberta Environment, and the National Air Pollution Surveillance Program (NAPS) also illustrate a commitment to inter-jurisdictional cooperation. During the Panel's public engagement sessions, aboriginal representatives particularly cited the Northern River Basins Study process as a good example of cooperation and collaboration.

These examples are a starting point for the formulation of future cooperative plans with other jurisdictions such as the Northwest Territories and Saskatchewan. Alberta is engaged in bilateral discussions with Saskatchewan on air issues and with the Northwest Territories on water issues. The Government of Canada has various responsibilities in the oil sands region through the *Fisheries Act*, the *Canadian Environmental Protection Act*, the *Canada Water Act*, the *Species at Risk Act*, the *Navigable Waters Protection Act*, and the *National Parks Act*. The *Canadian Environmental Assessment Act* is the framework within which major development projects are approved (or not), and the Department of Indian and Northern Affairs has water responsibilities on northern and reserve lands through the *Indian Act*.

Much could be gained by implementing cooperative approaches to monitoring that bring together the diverse and substantial expertise found in all levels of government, industry and university research communities across Canada. The onus is on both the federal and provincial governments to be engaged in environmental management in Alberta. Many opportunities to share expertise exist now and more will emerge. The Alberta system should take advantage of scientific knowledge that resides within Environment Canada to build and enhance capacity within a world class Alberta environmental monitoring system.

Effective cooperation and collaboration help partners avoid duplication of effort, achieve cost-effectiveness, and relieve conflicts in jurisdictional responsibilities through harmonization. Failure to achieve enlightened cooperation between federal and provincial agencies could result in inefficient, ineffective, duplicative—and perhaps discordant—efforts to more effectively regulate and monitor development projects.

Recommendation 4:

Improving Federal and Provincial Environmental Coordination and Cooperation

The Panel recommends that Alberta take a lead role in clarifying the roles and responsibilities of Alberta and Canada with respect to environmental monitoring to achieve world class results that reflect scientific and operational excellence.

3 The Current Approach to Monitoring in Alberta

3.1 A Short History of Environmental Monitoring in Alberta

Early environmental monitoring in Alberta had two components:

- Long-term networks that measured environmental trends and condition; and
- Monitoring to ensure compliance with resource agreements and project approvals.

Long-term ambient monitoring has been done for over 100 years, beginning with water flow measurements and weather monitoring. Surface water quality assessments have been conducted on lakes and rivers since the 1940s. Groundwater monitoring began in the late 1950s, with more comprehensive long-term land and air monitoring networks developed shortly thereafter. Initially, these long-term networks focused on basic inventories and descriptions of environmental issues specific to air, land, water or biodiversity, or to specific resource management issues. Long-term networks have provided a valuable source of consistent data sets over time.

During the 1950s and 1960s, municipal and industrial sources of pollution became a concern and environmental factors began to be considered in human health assessments. More systematic data collection programs were implemented in the late 1960s. With the development of provincial environmental legislation in the 1970s, monitoring and reporting of point source discharges was added to regulatory requirements and compliance activities.

When the Alberta Department of Environment was created in 1971, most monitoring was carried out by Ministry staff. Monitoring activities expanded at this time to include non-point sources associated with logging, agriculture, mining, urban development and atmospheric deposition. In 1973, the first Environmental Impact Assessment was completed for an oil sands mine, furthering the breadth of environmental monitoring.[1]

In the 1980s and 1990s, concerns emerged about the general health of ecosystems because of the detection of minute quantities of pollutants in various ecosystem components and because of growing public awareness of issues like climate change and species habitat loss. At the same time, cutbacks in public spending resulted in a

[1] See Appendix D for a more detailed description of industrial development and monitoring in the Lower Athabasca region.

decrease of government-led monitoring and research activities. Fiscal restraint and increasing public concern about the environment resulted in industry partnering with specific communities to initiate effects-based monitoring.

Monitoring has recently come under intense scrutiny as a result of increasing awareness and some high-profile incidents in the Lower Athabasca region. This scrutiny has culminated in growing demand for a science-based environmental monitoring, evaluation and reporting system to provide credible and trustworthy data.

3.2 Existing Monitoring Activities

Alberta Environment is required through legislation to conduct a wide range of monitoring activities, including those required by approvals and licensing, environmental assessment, substance release reporting, and conservation and reclamation. Industries and other regulated entities are required to undertake compliance monitoring and submit their compliance data to the appropriate regulator(s) as part of their approval conditions.

Many players are involved in environmental monitoring throughout the province. Ambient air, for example, is monitored by Alberta's airshed zones, Alberta Environment, Environment Canada, and industries that have air monitoring as part of their approvals or that do it voluntarily. Alberta Environment, municipalities, industry and others monitor water quality and quantity and, in some cases, water use. Other ministries and agencies of the Alberta Government also do environmental monitoring, among them Alberta Agriculture and Rural Development, Alberta Sustainable Resource Development, the Energy Resources Conservation Board and the Alberta Geological Survey. Environment Canada monitors water quantity through the Hydrometric Program and it does some water quality monitoring as well. In the Lower Athabasca, the Regional Aquatics Monitoring Program (RAMP), a multi-stakeholder group funded by industry, has been monitoring water since 1997. Universities and other research organizations also conduct studies that involve environmental monitoring, evaluation and reporting.

More than a dozen organizations are involved in environmental monitoring in the Lower Athabasca region alone, with each focusing generally on one aspect: air, land, water or biodiversity (Appendix E). Some have been active for a number of years, gaining valuable knowledge and experience, developing solid scientific programs and adapting them to changing circumstances, accumulating data, and establishing a strong presence in the local community. However, across this wide range of activity there is little coordination or integration, although millions of dollars are spent annually by these organizations on monitoring activities.

Human Health Monitoring

At the Panel's engagement sessions, a number of presenters shared their concerns about health. The Panel noted concerns raised by presenters about the role that exposure to chemical pollution in the environment may have on health and the occurrence of diseases in the Lower Athabasca region.[4]

Activities that will emerge as part of a world class environmental monitoring, evaluation and reporting system will add value to human health assessment, particularly as data and information are made publicly available. However, environmental monitoring alone is not sufficient to establish a relationship between environmental quality and health effects, and must be supplemented by ongoing disease surveillance. Alberta Health and Wellness and Alberta Health Services undertake such disease surveillance in the province.[5] Alberta Health and Wellness and Alberta Health Services are collaborating with the University of Alberta School of Public Health to develop, implement, and operate an Environmental Public Health Surveillance System. The surveillance system seeks to examine the relationships between diseases in populations in different areas of Alberta and factors in the environment. Although this surveillance system is important, the Panel is of the view that environmental public health surveillance is outside the mandate of any new monitoring, evaluation and reporting organization. As with similar systems being developed elsewhere in North America and Europe, health surveillance should remain within the public health system.

3.3 Assessing the Current System

As noted, environmental effects are monitored in Alberta through individual monitoring networks that are located in different parts of the province, with different governance and operational structures and different objectives. As in many jurisdictions across North America, these networks are not integrated nor are they optimally configured to support cumulative effects management. Considerable effort and substantial financial resources are being expended to collect large amounts of data, particularly in the Lower Athabasca region, but the results of this effort are not seen as adequate by most observers.

Recent reports commissioned by the federal government, the provincial government and the Royal Society of Canada have closely scrutinized monitoring, evaluation and reporting practices in the Lower Athabasca region. Most of the analysis and recommendations in those reports focused on surface water monitoring.

[4] Health and the occurrence of diseases within the population are determined by complex interactions between individual behaviors and genetics, the physical environment, and social and economic factors. These are referred to as "determinants of health."

[5] Additional information about this work is available online at **www.health.alberta.ca/services/public-health-services.html** and at **www.albertahealthservices.ca/1702.asp**. Examples of completed and ongoing health surveillance activities in the oil sands region include the Northern River Basins Human Health Monitoring Program, 1994–2004; the Alberta Oil Sands Community Exposure and Health Effects Assessment Program, 1998 – ongoing; and the Alberta Biomonitoring Program, 2008 – ongoing (Government of Alberta, 2010).

The Oil Sands Advisory Panel (2010) noted that current monitoring lacks consistency and coordination. While "a significant amount of data [has been] collected, there is a limited capability to ensure that the new knowledge created by the monitoring activity is actually able to be used by decision-makers." They recommended that a monitoring system "founded on accepted scientific principles" be established and noted that "a scientific culture will ensure the integrity of the system."

The Royal Society of Canada Expert Panel (2010) echoed concerns about lack of confidence in data being used to make decisions and the need for increased scientific presence: "The people of Alberta must be able to have confidence that such regulatory decisions are being made by highly skilled, senior technical specialists based strictly on the merits of scientific, technical, and economic evidence free of political interference."

These and other independent scientific reviews identified various deficiencies with the current system. While not all monitoring organizations and activities are deficient in the same areas, shortcomings generally focus on the following themes:

- Monitoring programs are not properly designed. Monitoring requirements have evolved over time and program design has, in many cases, not kept pace.
- Monitoring organizations suffer from inadequate funding, weak scientific direction, and a general lack of resources to take on the enormous challenge of monitoring.
- Monitoring results are not communicated or made available in transparent, useful formats.
- Multiple independent organizations managed by stakeholder boards are not well organized to achieve either holistic scientific objectives or operational excellence. Consequently, the overall "state of the environment" is not well understood.

Of particular concern is a lack of scientific oversight of monitoring, evaluation and reporting activities, resulting in an inability to:

- Identify critical knowledge gaps that prevent meaningful long-term monitoring and effective adaptive management;
- Provide sufficient feedback to develop standard environmental monitoring methods, which are presently lacking, particularly in the Lower Athabasca region; and
- Establish meaningful environmental baselines and reference conditions essential for cumulative effects monitoring; most reference stations in the oil sands area have been lost as development expanded.

This is very much the message that emerged from the work of the Alberta Water Monitoring Data Review Committee (2011). The Committee felt that scientific oversight and leadership would be essential to upgrading present activities to a world class system capable of sound cumulative effects monitoring. It is not the intent of this Panel to diminish the environmental monitoring work carried out by others; rather, we wish to emphasize the importance of scientific direction, strong organizational structures, adequate skilled staff and a commitment to operational excellence.

Environment Canada (2011), working with scientists from Alberta Environment and with key scientists from the university sector, has prepared a science plan for water quality work in the Lower Athabasca Basin (see Section 6.1). Subsequent phases of this plan will deal with groundwater and air quality. Many of the knowledge gaps identified by the Water Monitoring Data Review Committee have been addressed and amplified in the Environment Canada plan, and all of the scientists on the Data Review Committee feel that cooperation between the provincial and federal monitoring initiatives will be crucial to future success.

Much of the proposed monitoring work may become routine once appropriate standards and procedures have been established. However, given the unique, long-term and changing nature of the oil sands environment (see Appendix D), a range of new scientific issues will likely emerge that will require the continuing attention of qualified scientists and researchers. An environmental monitoring organization must have sufficient scientific expertise and capacity to carry out in-house research on at least key aspects such as method development. For this reason, the establishment of a world class monitoring system should only be undertaken as a long-term project with clearly defined commitments to long-term funding and support within industry and government.

3.4 The Need for a New Approach

The Panel concluded that the amount and quality of environmental monitoring, evaluation and reporting in Alberta require substantial improvement. The shortcomings of uncoordinated programs designed and executed to varying standards became evident as the Panel visited field locations and discussed monitoring challenges with scientific experts and stakeholders.

The Government of Alberta has identified the need for high quality environmental monitoring throughout the province. The Panel notes that it would be insufficient to simply provide more funding to expand the number of monitoring sites or the frequency of observations. A new approach is needed, with improved and expanded baseline monitoring and effects monitoring programs, designed and executed as part

of an environmental monitoring, evaluation and reporting system that uses advanced scientific protocols and methodologies. The Lower Athabasca region has particularly difficult challenges associated with cumulative effects monitoring and evaluation. World class scientific input is needed to develop better methods of analysis and understanding of uncertainties associated with impacts assessment within a framework of adaptive management.

The Panel is of the view that certain existing monitoring programs should continue while others may need to be restructured or replaced. The Wood Buffalo Environmental Association, for example, monitors air quality and terrestrial ecosystems in the Lower Athabasca region and demonstrates many of the operational and scientific attributes that the Panel considers essential for a world class monitoring, evaluation and reporting system. The Alberta Biodiversity Monitoring Institute monitors biodiversity on a province-wide scale and likewise reflects many of these same attributes. Programs now operated by these organizations would continue to add value if included in a comprehensive regional environmental monitoring program with secure long-term funding.

Deficiencies in monitoring, evaluation and reporting in other parts of the province will be different from those in the Lower Athabasca, and may be more or less severe. The Panel recognizes that monitoring programs have been developed in many regions, consistent with the unique requirements of each region. A regional approach to monitoring is appropriate and should align with the regions identified in the Land-use Framework. Notwithstanding regional differences across Alberta, the Panel's view is that an effective system designed and implemented for the Lower Athabasca region could be tailored and extended to all regions of Alberta.

Shortcomings in Alberta's environmental management practices are not unique; indeed, similar shortcomings would be found in most regions and jurisdictions of North America and internationally. The recommendations of this Panel aim to elevate Alberta's environmental performance to best-in-class, as measured by world class standards.

Recommendation 5:

A New Monitoring, Evaluation and Reporting System for Alberta

The Panel recommends that a province-wide monitoring, evaluation and reporting system be organized on a regional basis, aligning with the boundaries described in the Alberta Land-use Framework. The new system would provide regional and province-wide information that is timely and useful to government, regulators, industry, researchers, stakeholders and the public.

4 A New Environmental Monitoring, Evaluation and Reporting System for Alberta

Alberta should aspire to lead the world in developing and operating a holistic environmental monitoring, evaluation and reporting system. Both the system and the organization that implements it must be grounded in principled science and committed to operational excellence. A world class environmental monitoring system will earn international credibility and deliver high quality information to government, regulators, industry and other stakeholders.

4.1 Values and Principles

The Panel has identified four key values and principles that must govern the design and operation of a respected environmental monitoring, evaluation and reporting system. These four values and principles must be embraced and applied at all levels to ensure consistency and alignment.

LEGITIMACY: Governments must deal with the inherent conflict of being the resource owner, regulator and revenue taker. For the new monitoring system to have the requisite legitimacy and scientific credibility, the system must operate at arm's length from all affected parties, including governments, regulators and those being regulated. An arm's length relationship does not prohibit communications between communities; indeed, discussion between the scientific and regulatory communities and regulated industries can be critical when defining overall monitoring goals. To be legitimate, information produced must respect stakeholders' values and be fair in its treatment of opposing views and interests (Cash *et al.*, 2003).

CREDIBILITY: To be credible, the information that arises from a monitoring program must be regarded by stakeholders as scientifically sound and free of bias or perceived bias (Cash *et al.*, 2002, 2003). Science must drive the design, execution and evaluation of monitoring programs that are delivered or managed and funded through the new environmental monitoring, evaluation and reporting system. Data must be gathered and evaluated in accordance with scientific best practice. Transparency contributes to credibility and will be a hallmark of monitoring programs and the data and information they produce.

RELEVANCE: To be relevant, information produced by the system must meet the needs of stakeholders in a comprehensive, understandable, useful and timely manner (Cash *et al.*, 2002, 2003). Stakeholders include provincial and regional governments, regulators, researchers, industry, communities adjacent to developments, and others who use the information generated. To be relevant, monitoring programs must consider stakeholder concerns, determine if environmental effects exist, and explain the major issues and environmental effects that have been identified. To ensure relevancy, monitoring programs must adapt to new information and requirements that emerge over time.

OPERATIONAL EXCELLENCE: A strong commitment to operational excellence will drive strong performance in all aspects of environmental monitoring, evaluation and reporting. The environmental monitoring, evaluation and reporting system must demonstrate excellence in monitoring operations and deliver the best possible information in a timely, efficient and fully accountable manner. Accountability to stakeholders will help the system adapt and will encourage continuous improvement based on new knowledge, technology, needs and circumstances.

Commitment to these values and principles will build trust and confidence in the new monitoring system.

Recommendation 6:

Values and Principles

The Panel recommends that the following values and principles be adopted to guide the development and operations of the environmental monitoring, evaluation and reporting system:

LEGITIMACY: The environmental monitoring, evaluation and reporting system must be independent of government, industry and special interests.

CREDIBILITY: Science must drive the design, execution, evaluation and reporting of monitoring programs. Activities must be conducted in an open and transparent manner.

RELEVANCE: Information provided by the environmental monitoring, evaluation and reporting system must meet the needs of stakeholders.

OPERATIONAL EXCELLENCE: The environmental monitoring, evaluation and reporting system must demonstrate excellence in all aspects of field monitoring, evaluation and reporting.

4.2 Architecture for a New Monitoring, Evaluation and Reporting System

A legitimate, credible, relevant, and operationally excellent environmental monitoring system will meet the needs of a variety of users and continually improve to reflect state-of-the-art scientific thinking and the unique circumstances of the day. It will include a scientific database system and an information system that helps managers and informs government, regulators, industry, the scientific community and the public. Seven important functions define the integrated aspects of a new monitoring, evaluation and reporting system for Alberta (Figure 3), starting with a definition of user needs:

- User Needs – Understanding the information needs and desired outcomes of users
- Monitoring Program Design – Developing sampling programs and protocols to achieve desired monitoring outcomes
- Data Acquisition – Implementing data acquisition protocols, including protocols for data acquisition through primary field work
- Data Management – Receiving and storing data
- Data Evaluation – Generating information through data analysis
- Knowledge (and Information) Dissemination – Making monitoring results available
- Knowledge (and Information) Application – Supporting integration of results back to stakeholders and the monitoring system

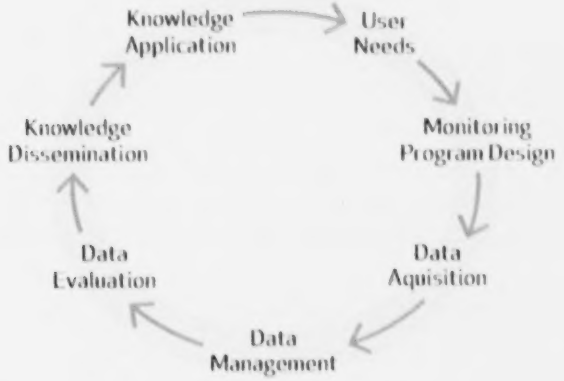

FIGURE 3. *Architecture for a continually improving monitoring, evaluation and reporting system*

There is a logical flow through these seven elements but, in reality, many of the elements interact in a more fluid way. A dynamic system of feedback loops and mechanisms allows interaction and integration among the key elements at any point in time. Overall operation of the system is guided by the principles noted previously.

4.3 Scientific Attributes

"World class" implies a standard that transcends any one country or cultural group. As applied to science, the term reflects not only a common standard, but a process that philosophers have long hailed as a social equalizer. It is merit, and merit alone, that brings scientific credibility. The scientific process that has developed over time is self-correcting and based on uncensored and clear communication. It retains and builds on what works, and rejects or discourages what does not. In this way it is an adaptive process, not one that guarantees answers that are universally "correct" but, rather, answers that are transparent and open to scrutiny. In other words, it is the process itself that works and it is transparent communication and open debate combined with peer review that allows the self-correcting mechanism to function.

A world class monitoring system provides information consistent with a world class scientific standard of evaluation. It allows decision makers to react to environmental impacts with changes in policy to preserve the natural integrity of our world, and thus maintain the sustainability of our enterprises within it. The monitoring system should allow us to focus our search on environmental effects that prior studies suggest might reasonably happen. This open and rational approach makes the information generated of interest to the best scientists in the world and stimulates broad participation in the process.

A world class monitoring, evaluation and reporting system for Alberta must have science at its core and include a number of key elements:

- High level scientific expertise must be applied to all aspects of the monitoring and evaluation program.
- Essential steps include identifying monitoring goals; defining monitoring design and methods; design and installation of monitoring equipment and data retrieval infrastructure; data acquisition, quality assurance and archiving; and interpretation and analysis, including modeling. Feedback and opportunities for re-evaluation are important at every step.

- All aspects of the monitoring, evaluation and reporting process must be open to scrutiny and peer review. Free access to data is a fundamental requirement of openness and transparency, and is likely to generate substantial additional unpaid input to the critical analysis and review process. Some aspects of the process will be suitable for peer review through publication in international journals.
- Monitoring and evaluation must be integrated and coupled in an adaptive process. Among other things, this will provide efficiency and enable focused effort on emerging problems.

Given the scope of the environmental issues in Alberta, particularly in the Lower Athabasca region, a team of qualified scientists with a wide range of skills will be needed to design and implement a world class monitoring, evaluation and reporting system. Figure 4 illustrates how such a team could be organized and reflects the integration of science throughout the organization.

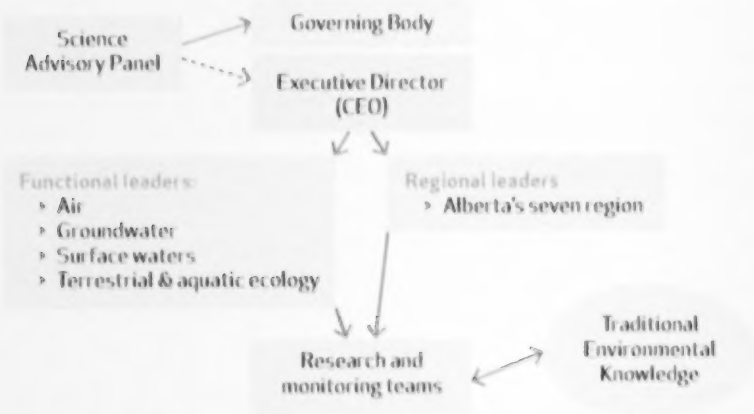

FIGURE 4. *Scientific elements of a monitoring organization*

As well as functional leaders, specialists will also be required in specific sub-areas (e.g., aquatic biochemistry, ecology, hydrology, modeling), and they will need to communicate effectively to address issues that cut across air, land, water and biodiversity and science boundaries. The calibre of the science should be constantly evaluated. The Panel recognizes the value of Traditional Environmental Knowledge and believes it should be incorporated in the monitoring, evaluation and reporting activities.

In-house or qualified external laboratory facilities will be needed to support regional monitoring programs and to ensure consistency and strong scientific oversight.

Recommendation 7:

Scientific Oversight and Rigor

The Panel recommends that science be the primary driver of the design and execution of monitoring, evaluation and reporting activities. All monitoring, evaluation and reporting activities must demonstrate scientific rigor and continually adapt to environmental change, local and regional needs, evolving scientific knowledge and advances in technology.

4.4 Data Management, Information and Reporting

The primary operational attributes of an integrated monitoring, evaluation and reporting system include a focus on data management and the dissemination of the resulting knowledge and information.

Data Management

Standardized policies, processes and procedures for the management of data and information are the foundation of efficient data management. Many jurisdictions and organizations have established policies and procedures governing access to and use of data and information, along with custodial guidelines and information management strategies. A primary goal is the creation of accurate, consistent and transparent data content, emphasizing data precision, granularity and meaning. Equally important is the integration of content into business applications and how it is shared between processes and partners.

Achieving these goals starts with the development and implementation of a data policy that:

- Provides best practice quality assurance mechanisms that produce validated, well documented data sets that meet priority information requirements;
- Archives collected data, ensuring data are available for multiple uses, safeguarding and securing data for future use, conforming to data policy;
- Improves the effectiveness and efficiency of policy and program development through the coordination of data and information activities;
- Provides timely, accurate and up-to-date data, information, and information products to support a wide range of activities; and
- Ensures that data and information are easily accessible to a wide range of users in a timely fashion.

To meet Alberta's needs now and into the future, the environmental data management system must take a holistic approach to data collection, integration and management. Since the value of a data set is increased by increasing the capacity to collect data across a range of spatial and temporal scales, new methods for data acquisition, analysis, management and reporting should be developed and applied to reduce costs. Examples include development and implementation of remote sensing protocols for data collection, or machine learning protocols for remote detection of trends or alarms.

Various data management functions are needed to ensure data credibility, relevance and legitimacy. Several of these functions are overarching and apply to all parts of a world class monitoring, evaluation and reporting system: quality assurance; quality control; metadata; documentation; and excellence in human resources, organization and management. Others are functional needs that apply specifically to data management: data security and back-up; data processing and storage; and data handling processes.

Information and Reporting

A key purpose of the monitoring system is to provide information on Alberta's environment to support policy development, regulatory processes and responsible environmental management. The monitoring system must provide trusted, value-neutral, and authoritative information about the health of Alberta's environment.

The value that the environmental monitoring system brings to stakeholders will only be fully realized with appropriate information dissemination activities. Information dissemination involves distributing information to stakeholders, managing information requests from stakeholders, and communicating with the media, public and clients. This function should support:

- Formulation of public policy in the areas of cumulative effects, land use planning and specific aspects such as water, energy, agricultural and climate change policy;
- Stewardship management and reporting at provincial, regional and municipal levels. This will contribute to better knowledge and understanding of status and trends, market-based instruments for conservation and stewardship, reclamation, and monitoring of ecological goods and services;
- The research community by providing access to raw data; access to modeling and analysis tools; tools that can assist collaboration; and news and links to related academic and research institutions; and
- Public awareness through environmental literacy campaigns, environmental interest stories in the media, government relations and brand awareness.

Dissemination activities will provide stakeholders with access to raw data, summarized data, reports, website applications, and other forms of information. Information should be shared primarily through an electronic portal that is consistent with today's communications technologies and coupled with additional complementary communications activities. Tools that could be used for this purpose include: a website and information portal, traditional media, printed and online reports, social media, presentations to stakeholders, public relations, stakeholder workshops and meetings, and linkages with other portals and agencies with sources of expertise.

The dissemination of high quality, trusted information will build the profile and establish the brand of Alberta's environmental monitoring, evaluation and reporting system.

Recommendation 8:

Data Management, Information and Reporting

The Panel recommends that Alberta's environmental monitoring, evaluation and reporting system include a coordinated, publicly accessible data management system for baseline monitoring data, compliance monitoring data and effects monitoring data, with protocols to ensure transparency in data collection, analysis, reporting, and conveyance to government.

5 The Alberta Environmental Monitoring Commission

The Alberta Environmental Monitoring Panel considered and discussed the values, principles, attributes and challenges of a new environmental monitoring system. The Panel agreed that a world class monitoring, evaluation and reporting system must demonstrate scientific and operational excellence to deliver high quality information and earn the respect of a wide range of stakeholders. The Panel believes a new agency, the Alberta Environmental Monitoring Commission, is the best mechanism to deliver world class results.

5.1 Governance and Organization

The Panel considered a number of governance and organizational alternatives to deliver a world class environmental monitoring system. Options ranged from internalization within government to a multi-stakeholder structure to the establishment of a special purpose government agency.

The Panel heard from stakeholders in Alberta and across Canada, as well as from government officials, industry leaders and Aboriginal and environmental organizations. The Panel also reviewed *At a Crossroads*, the 2007 report of the Board Governance Review Task Force, and the *Public Agencies Governance Framework*, the Alberta Government's response to the Task Force's recommendations. Finally, the Panel assessed a range of governance systems from several jurisdictions to develop optimal recommendations for Alberta.

The Panel examined five options:

1. *Status Quo*
2. Internalization within Alberta Environment
3. Multi-stakeholder Organization
4. Coordinating Environmental Monitoring Organization
5. Comprehensive Environmental Monitoring Organization.

A comprehensive, arm's length, centrally-managed organization with strong regional operations has the highest likelihood of delivering world class environmental monitoring, evaluation and reporting. Option 5 is, therefore, the Panel's preferred alternative.[1]

[1] See Appendix F for a description of the five options and the Panel's rationale for its choice.

The Board Governance Review Task Force (McCrank *et al.*, 2007) examined the scope and characteristics of existing Alberta Government agencies, and its work informed the Panel's consideration of governance and organizational alternatives. In response to the Task Force's report, the Government of Alberta published the *Public Agencies Governance Framework*, which describes an agency as a board, commission, tribunal or other organization:

- that is established by government but not part of a government department;
- that has been given responsibility to perform a public function;
- that is accountable to government;
- that has some degree of autonomy from government; and
- for which the government holds the primary power of appointment.

The new organization envisioned by the Panel and described in the balance of this report meets the Government of Alberta's criteria for a public agency under the *Public Agencies Governance Framework*. The Panel believes that this new organization—the Alberta Environmental Monitoring Commission—should be established with some urgency.

Recommendation 9:

The Alberta Environmental Monitoring Commission

The Panel recommends that Alberta establish the Alberta Environmental Monitoring Commission as a science-driven, arm's length, and operationally excellent public agency. The Commission would be responsible for baseline monitoring, effects monitoring and state of the environment monitoring in all regions of Alberta.

5.2 Vision and Mission

Vision

The Alberta Environmental Monitoring Commission will be recognized for the scientific design and execution of provincial monitoring programs, the thoroughness and accuracy of programs for environmental measurement and evaluation, and the relevance and transparency of published data and information. The Commission will be respected for its scientific, organizational and operational excellence; for its effective collaboration with other organizations and agencies; and for its transparent and effective governance.

Mission

The Commission will provide accurate, trustworthy and useful data and information to inform the work of policymakers, regulators, research organizations and others through the design, execution and supervision of environmental monitoring programs for air, land, water and biodiversity.

5.3 Mandate

The Commission will gather data through its own programs, through programs operated by others, and through partnerships with industry, universities and others. Data and reports prepared by the Commission will be made available in useful formats to stakeholders.

The Commission will focus its initial efforts on the Lower Athabasca region, thereafter expanding its programs, in a phased manner, to include all regions of Alberta.

The Commission will have a strong commitment to scientific inquiry, flexibility and continuous improvement. Designing and establishing a world class environmental monitoring, evaluation and reporting program is scientifically sophisticated work. Scientists engaged in such work would also undertake research into the practice of environmental monitoring and the impacts of human activities on the environment. The Commission's mandate will therefore include a clear commitment to research and science in all aspects of environmental monitoring, evaluation and reporting.

The Commission will not be responsible for compliance monitoring or have any role in inspections or enforcement. However, the Commission's scientific expertise would be of value in the design, evaluation and ongoing development of compliance monitoring programs. The Commission will have access to all compliance data and will work with regulators and industrial operators to maximize the value of compliance monitoring programs.

It is the Panel's view that the new environmental monitoring system will add substantial value to the existing compliance monitoring system in two ways: 1) the Commission will have the ability to undertake regional compliance monitoring in areas where such monitoring is needed or where the Government of Alberta asks it to do such monitoring; and 2) the Commission will provide scientific and technical advice to government and regulators on substances to be monitored, and on monitoring methodologies, sampling techniques and related protocols. This will assure regulators, industry and Albertans that the compliance monitoring system is based on world class science and leading-edge techniques and will lead to improvements as new advances are incorporated.

As a first step, the Commission should assume responsibility for coordinating existing monitoring, evaluation and reporting activities in the Lower Athabasca region. Existing Lower Athabasca programs would continue to be executed by organizations such as the Wood Buffalo Environmental Association and the Alberta Biodiversity Monitoring Institute, under the supervision of the Commission. Such programs could continue in their current form indefinitely, or they could become internal programs managed and operated by the Commission. Either way, the Commission would assume responsibility for the quality and efficiency of all environmental effects monitoring programs in the Lower Athabasca region. This means industry-specific regional effects-based compliance obligations will need to be transferred to the Commission.

Experience gained in the Lower Athabasca region would then guide the expansion of activities to the rest of Alberta, with intent to develop consistent approaches, operating practices and standards for environmental monitoring, evaluation and reporting throughout the province. The Commission would also provide periodic, factual reports to inform government, regulators, industry, other stakeholders and the public about the state of Alberta's environment.

Recommendation 10:

Commission Mandate

The Panel recommends that the Alberta Environmental Monitoring Commission:

a. Be responsible for field monitoring, data evaluation and reporting of environmental conditions, including baseline monitoring and effects monitoring for all regions of Alberta;

b. Be responsible for all aspects of environmental effects monitoring, whether field activities are conducted directly by the Commission or by other entities acting for the Commission. The quality and efficiency of all monitoring programs would be the responsibility of the Commission;

c. Where appropriate, assume direct responsibility and accountability for regional effects monitoring programs currently carried out by industry or by stakeholder organizations; and

d. Have access to all compliance monitoring data as input to its evaluation and reporting activities. The Commission could provide technical and scientific advice and assistance to government and regulators regarding the design and operations of compliance monitoring activities. However, the Commission would not be responsible for compliance enforcement.

5.4 Integration with Existing Research Entities

In the interest of building on an existing model, the Panel looked at the Alberta Innovates system established by the *Alberta Research and Innovation Act* in March 2009. This Act transformed Alberta's research and innovation network of ten research foundations and Crown corporations into four new board-governed provincial corporations. Each corporation has an independent Board of Directors, a chief executive officer and staff who are employed by Alberta Innovates. Ultimate accountability for Alberta's research and innovation system rests with the Minister of Advanced Education and Technology (AET).

The four corporations are funded through the AET budget, upon the recommendation of the Portfolio Advisory Committee (PAC), one of two bodies formed to advise the Minister. The PAC is chaired by the Minister of AET and is composed of Ministers of all departments involved with the four corporations (Environment, Energy, Sustainable Resource Development, Agriculture and Rural Development, Health and Wellness, and Finance and Enterprise). The PAC advises the Minister on planning and funding matters related to the four corporations and on research and innovation priorities for the Government of Alberta.

The second advisory body to the Minister is the Alberta Research and Innovation Authority (ARIA). Its advice is intended to position Alberta for global competitive advantage and leading edge research and innovation. To promote alignment and integration of the four corporations and ensure consistency with the Government of Alberta's overall direction, the Alberta Research and Innovation Committee was formed. This Committee is composed of the four Board chairs and the Minister of AET.

Establishing a new monitoring Commission that is similar to and aligned with the Alberta Innovates structure offers two important strengths and advantages:

- It would encourage and facilitate cooperation and synergy between two Alberta-based systems that have strong science, research and innovation elements, thus optimizing resources.
- The processes and structures are familiar to government departments that would be involved with the new monitoring Commission.

Following the Alberta Innovates model, the Minister of Environment would be accountable for the Commission, and would establish a Monitoring Advisory Committee (MAC), similar to the Portfolio Advisory Committee established to coordinate the Alberta Innovates system. The MAC would include the Ministers

of Energy, Sustainable Resource Development, Agriculture and Rural Development, Health and Wellness, Finance and Enterprise, and Advanced Education and Technology. Regional Advisory Committees would provide advice to the Commission as well.

Also following the Alberta Innovates model, the new Commission would have an independent Board of Directors, appointed by and accountable to the Minister of Environment. The Board would select the Executive Director, and staff would be employed by the Commission. The two systems are illustrated in Figure 5.

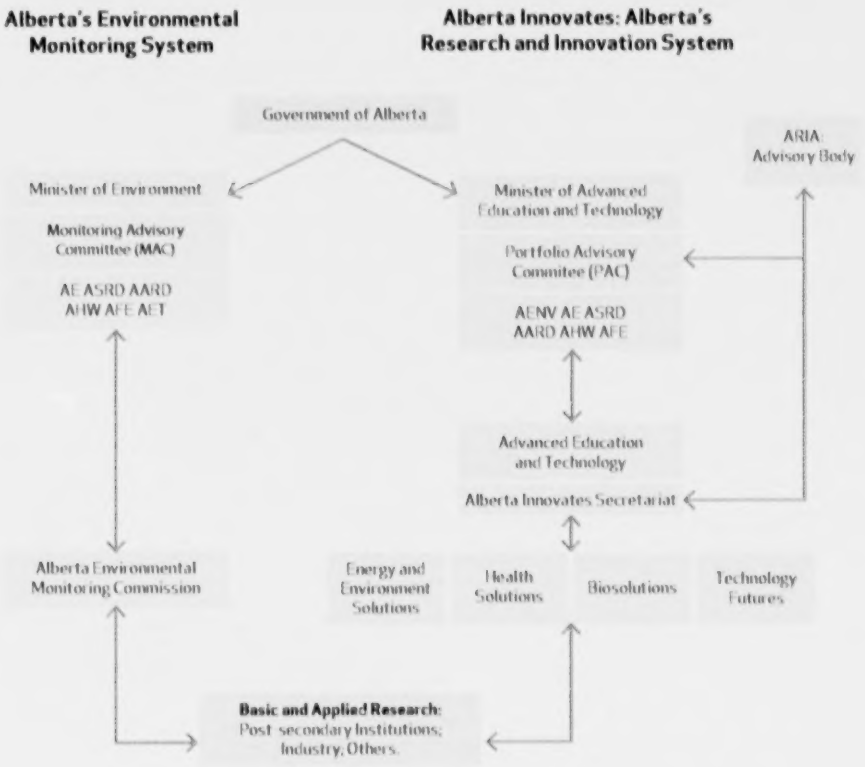
Alberta's Environmental Monitoring System
Alberta Innovates: Alberta's Research and Innovation System
Government of Alberta
ARIA: Advisory Body
Minister of Environment
Minister of Advanced Education and Technology
Monitoring Advisory Committee (MAC)
AE ASRD AARD AHW AFE AET
Portfolio Advisory Committee (PAC)
AENV AE ASRD AARD AHW AFE
Advanced Education and Technology
Alberta Innovates Secretariat
Alberta Environmental Monitoring Commission
Energy and Environment Solutions
Health Solutions
Biosolutions
Technology Futures
Basic and Applied Research: Post-secondary Institutions; Industry; Others.

FIGURE 5. *Comparison of Alberta Environmental Monitoring System and Alberta Research and Innovation System*

It is envisioned that the Alberta Environmental Monitoring Commission and entities within Alberta Innovates would work closely together to meet the research-related needs of government, regulators and industry.

In addition to strong links with the Alberta Innovates structure, there are fiscal and scientific advantages to closely associating the Commission with the Canadian university research community, similar to the approach of the Alberta Biodiversity Monitoring Institute. Such an association could aid in the recruitment and retention of human resources, help Commission staff stay current with emerging technologies, leverage research funding for scientific inquiry, bring local expertise and resources to bear in support of environmental monitoring, build related capacity within the institutions, and promote the training of the next generation of environmental leaders.

Recommendation 11:

Coordination with Alberta Government Ministries and Corporations

The Panel recommends that the Minister of Environment create a Monitoring Advisory Committee to coordinate cross-ministry interests.

Recommendation 12:

Coordination with Other Teaching and Research Organizations

The Panel recommends that the Alberta Environmental Monitoring Commission coordinate its research-related activities with Alberta Advanced Education and Technology and Alberta's universities and colleges.

5.5 Governance of the New Commission

As reflected in the Panel's recommendations, the fundamental factors for success of the Commission are: the ability to operate at arm's length from government; the authority to design, manage, execute and make decisions about environmental monitoring; strong commitments to scientific and operational excellence; and stable, long-term funding.

For the purpose of this report, "independence" is meant to convey the ability of the Commission to have a degree of autonomy from government, manage its own agenda, implement its decisions, and optimize the resources it manages. This operational independence is counter-balanced by the Minister's role in appointing the Governance Board and the Chair and Vice-Chair. It is acknowledged that the Commission, while operating at arm's length from Government, will be accountable through the Minister of Environment to ensure that it operates within its legislative mandate, including the *Financial Administration Act*. The Commission will also respond to issues and options presented to it by the Minister.

Governance Board

The Governance Board would be composed of respected individuals from diverse backgrounds and sectors, chosen on the basis of merit, with skills, knowledge and experience related to environmental monitoring, evaluation and reporting. The appointment of Board members would require them to act in the best interests of the Commission, setting aside special interests of their respective communities or stakeholders. The Board would be accountable to the Minister of Environment.

The Board would have overall responsibility for the governance of the Commission and would provide strategic direction. As one of its initial tasks, the Board would work with the Minister of Environment to develop a formal Mandate and Roles Document. More specifically, the Board would be responsible for:

- Establishing high standards of scientific and operational excellence;
- Ensuring the Commission is led and managed to achieve those high standards;
- Identifying appropriate Board governance processes to assist in fulfilling its mandate, including the development of policies that govern the roles and responsibilities of Board members and senior officers;
- Establishing a Code of Conduct for the Commission, and ensuring that all Board members, senior leaders and staff comply;
- Monitoring the Commission's performance and ensuring that all material developments and emerging issues are disclosed to the Minister on a timely basis;
- Overseeing compliance with all relevant policies, procedures and standards, and ensuring that the Commission operates at all times in compliance with all applicable laws and regulations, to the highest ethical standards;
- Engaging in a strategic planning process with a forward-looking strategic agenda; and
- Ensuring completion of annual reports.

Recommendation 13:

Governance Board

The Panel recommends that the Minister of Environment appoint a Board to govern the Commission. All Board members should be selected based on merit relevant to the Commission. The Board would be led by a Chair and Vice-Chair appointed by the Minister.

Board Chair

With direction from the Board, the Chair represents the Board and the Commission in dealing with Ministers, provincial and federal departments, stakeholders and Albertans. The Chair provides leadership to the Board and effectively facilitates the Board's work.

The Board Chair is responsible for:

- Overseeing and ensuring the performance of the Executive Director and the senior leadership team;
- Planning and managing Board meetings;
- Providing the Minister with regular updates on the Commission's operations and informing the Minister regarding emerging issues;
- Administering the Code of Conduct and ensuring that conflict of interest matters are addressed by the Board;
- Ensuring the Board conducts an annual evaluation of its own performance; and
- Monitoring the effectiveness of the Board and, where necessary, recommending to the Minister the removal of a Board member where cause exists.

Recruitment and Appointment of Board Members

The Board will prepare a competency matrix for the board as a whole and will determine the values and competencies required for individual directors. Areas of competence include but are not limited to those noted below:

- Technical operations and management
- Financial experience and acumen
- Human resources and organization
- The science of environmental monitoring
- Working in or with government
- Strategic planning
- Board governance.

The recruitment process will be led by the Minister. For the appointment of the initial Chair and Board members, it is expected that the positions would be publicly posted and that worthy candidates who apply, or are nominated, will be vetted by the Ethics Commissioner. When the Board is operational and a vacancy occurs, the Board will identify the competencies required and provide that profile to the Minister who shall initiate an appropriate process to fill the position, which includes vetting by the Ethics Commissioner. The Minister and the Board Chair will discuss the appointment of individual candidates before the Minister makes the official appointment.

Recommendation 14:

Interim Appointments

The Panel recommends that the Minister of Environment select an Interim Chair and Vice-Chair for the Commission, who would then consult with the Minister on the process of naming interim Board members. This is an urgent requirement and should be in place in a matter of months to expedite the transition from the current system.

5.6 Science Advisory Panel

The Science Advisory Panel would review monitoring, evaluation and reporting activities from a scientific perspective and make recommendations to the Executive Director and to the Board. Appointments to the Science Advisory Panel would be ratified by the Board. The Chair of the Science Advisory Panel should also serve as a member of the Board. The Panel is convinced that a Science Advisory Panel is essential for the Commission to avoid the pitfalls identified by prior assessments and for the new monitoring, evaluation and reporting system to achieve world class status.

Recommendation 15:

Science Advisory Panel

The Panel recommends that the Commission appoint a Science Advisory Panel composed of internationally-recognized experts in environmental monitoring, evaluation and reporting to provide independent advice on the design, implementation and quality of the Commission's monitoring, evaluation and reporting activities.

5.7 Aboriginal Participation

The aboriginal groups that participated in the Panel's engagement sessions expressed a keen desire to participate in a credible and transparent regional monitoring process – one that would involve them in all aspects of monitoring, from the collection of data to interpretation and evaluation of data and information, identification of knowledge gaps, and governance and planning. These groups displayed a highly sophisticated understanding of their legal rights, the industrial processes that are being carried out on their traditional lands, and environmental monitoring science and policy. However, the Panel also noted a high level of cynicism about government and industry-led monitoring and regulatory processes with which aboriginal groups have interacted in the past. To varying degrees aboriginal participants expressed deep frustration with

these processes, they felt the processes had not given credence to their concerns about cumulative impacts of oil sands development, were highly adversarial, and did not engage or empower them to participate as equals in the management of their Treaty Lands, rights for which they cited certain constitutional protections.

Representatives from Fort McKay and Fort Chipewyan felt that an open and transparent system that engaged the community and provided gainful employment opportunities for young people in activities centered on environmental stewardship would be well received. The Panel is aware of a Canada-First Nation Joint Action Plan to which Canada and the Assembly of First Nations recently agreed. This recognition by Canada to pursue enhanced cooperation between government and native leaders may signal a major shift in both leadership and attitudes toward joint initiatives. As such, it would be consistent with those initiatives to carefully examine the potential advantages of community-based monitoring programs in the aboriginal communities and lands in the Lower Athabasca region.

Recommendation 16:

Aboriginal Participation

The Panel recommends that the Commission establish a mechanism, in consultation with representatives from Treaties 6, 7 and 8 and the Métis Nation of Alberta, to enable aboriginal communities to develop a proposal for their participation in Commission activities, including community-based monitoring programs.

5.8 Stakeholder Participation

Stakeholder input will be a valuable source of information for the Commission. Such input would be useful for operational processes at the regional level and could occur through regional stakeholder committees or regional stakeholder engagement processes.

Opportunities for stakeholder engagement should also be provided at the provincial level, to gather input and advice on the overall monitoring, evaluation and reporting system. Such advice will need to recognize the scientific basis of the Commission.

Processes for regional and provincial stakeholder engagement should be developed by the Executive Director and approved by the Governance Board.

Recommendation 17:

Stakeholder Input

The Panel recommends that the Commission establish mechanisms to encourage and facilitate stakeholder input to monitoring programs in each region as well as at the provincial level.

5.9 Management

The Commission will require strong leadership in the form of an Executive Director, who will serve as the chief executive of the Commission. The Executive Director will be appointed by and will report through the Chair to the Governance Board. The Executive Director will be responsible for leading the senior management team, for developing and implementing the Commission's strategy, and for overall operations of the Commission. The Executive Director should have both scientific expertise and technical management credentials.

Several presenters at the engagement sessions stressed the need for robust management systems and the capacity to manage the new Commission "like a business." The Panel recognizes the importance of strong relationships between scientists and managers to achieve both operational and scientific excellence. Successful integration of business and scientific practices will be crucial to sustainability of the Commission. It will take time for the Commission and the management and monitoring systems it oversees to mature. The Implementation Plan described in Section 6 acknowledges this and proposes a phased approach.

5.10 Funding

The Commission will require adequate, stable, long-term funding for its operations, including related research. The Commission will need a dedicated revenue stream and the ability to manage its own funds, including the flexibility to carry funds forward from year to year. Assurance of stable, long-term funding, irrespective of source, is essential if Alberta is to establish and maintain a world class environmental monitoring, evaluation and reporting system.

The Panel examined the sources and mechanisms of funding for various monitoring programs. Funding for existing programs flows from a variety of sources including Alberta Environment, other Government of Alberta ministries, Environment Canada, other federal ministries, industry, municipalities and others.

Program funding appears to be generally *ad hoc*, unpredictable and inadequate to meet program objectives. Notably, there does not seem to be any sort of master plan for overseeing the funding of environmental monitoring programs in Alberta. The question of "value for money" is not addressed by any central agency, and programs to ensure coordination, cost-effectiveness, and scientific validity are not evident.

The Panel concluded that an assessment of Alberta environmental monitoring programs carried out by government and other organizations should be undertaken in the near term to identify opportunities to improve cost-effectiveness and eliminate overlap and redundancy. Cost-effectiveness could almost certainly be improved by coordinating existing monitoring programs and reconfiguring existing capital equipment to achieve more scientifically sound environmental monitoring outcomes.

Several concepts of who should pay for a provincial environmental monitoring system emerged during the Panel's engagement sessions, and the most common view was that industrial operators should pay. This model, commonly known as the "polluter pay" model, would not suffice in all areas of Alberta. An example of this approach is found in the Lower Athabasca region, where industrial operators pay the costs of several large and expensive regional monitoring programs. The "industry pay" model may be the appropriate mechanism to cover the costs of monitoring emissions from industrial operations. However, that would not cover all emissions in the Lower Athabasca region nor would it be appropriate in all regions of Alberta. For example, the cities of Edmonton and Calgary have significant environmental footprints, but have no dominant industrial operators to cover the full cost of environmental monitoring programs.

In the context of a province-wide system the "industry pay" model provides only a partial solution to the funding problem, particularly in regions where emissions are largely from non-point sources. The "industry pay" model is administratively complex, non-industrial emitters are often not included, there is a risk of variable fiscal support for regions and costs may be unfairly placed on industrial operations whose emissions are easiest to identify and quantify. In addition, the results of an "industry pay" model are seen by some stakeholders as suspect because of real or perceived conflict of interest.

It is reasonable to look to the provincial income tax system to fund a substantial portion of environmental monitoring costs. For example, citizens who utilize Alberta's air, land, water and biodiversity could have their share of monitoring costs covered by general government revenues.

The Government of Canada provides funding for many regional and Canada-wide programs conducted by Environment Canada. It is the Panel's view that federal funding is appropriate for Environment Canada programs that are not within the mandate or responsibility of the Alberta Environmental Monitoring Commission.

The development of detailed funding models is beyond the terms of reference of this Panel. The Government of Alberta must be ultimately responsible for providing adequate, stable and long-term funding for the environmental monitoring system.

Recommendation 18:

Funding the New Environmental Monitoring System

The Panel recommends that a dedicated and sustainable funding model be established to support the work of the Commission. Alberta should use its legislative authority and negotiating power to determine which parties should share the cost of implementing the required monitoring, evaluation and reporting system.

6 Implementation Plan

The Government of Alberta has indicated its desire to create a world class environmental monitoring, evaluation and reporting system for the entire province. Such a system will need to take into account the natural diversity of Alberta as well as the wide range of human activity that occurs in various regions. Establishing a system first in the Lower Athabasca region will build experience and credibility. While that work is underway, the Commission needs to look closely at other regions to identify specific monitoring challenges and determine the most appropriate way to configure the provincial system in the context of existing land use regions.

Preliminary plans for establishing operations in other regions should be developed during the first two years, with the intent of developing province-wide, science-based environmental monitoring activities over the first five years. Strong regional organizations covering all of Alberta should be in place by the end of year five. The Panel recognizes the very substantial challenges of establishing a comprehensive environmental monitoring program in every region, not least of which is cost.

6.1 The Lower Athabasca Region

Early activities of the Commission should focus on the Lower Athabasca region, and initial results will need to be demonstrated in the first year. However, several years will be required to establish and organize science-based environmental monitoring programs in the region. Experience, expertise and knowledge gained in this region will inform the process as the Commission extends its activities to other regions of Alberta.

Environment Canada, in association with Alberta Environment, has produced a cumulative effects monitoring plan for water quality in the Lower Athabasca (*Lower Athabasca Water Quality Monitoring Program—Phase 1*). This plan (Wrona and di Cenzo, 2011) addresses many water monitoring issues for the Lower Athabasca. The Panel sees an important and ongoing relationship between the Alberta Environmental Monitoring Commission and Environment Canada, with opportunities to draw on Environment Canada's facilities and expertise to support Alberta's monitoring activities in the Lower Athabasca region. A plan for Phase 2, aimed at monitoring biodiversity, the health of fish, and air is also being prepared.

The Panel views this program as a positive step towards improved environmental effects monitoring in the oil sands region. It provides a valuable contribution in defining the technical detail required for the initial implementation of an adaptive monitoring program. This technical detail complements the Panel's work, which focuses on the governance and operational framework required for the implementation of a world class monitoring, evaluation and reporting system for all areas of Alberta. The Environment Canada report demonstrates the potential for close collaboration and partnership between the proposed Alberta Environmental Monitoring Commission and Environment Canada.

6.2 Provincial Implementation

Formal responsibility for environmental monitoring in Alberta has evolved to include government departments at the federal and provincial level. As well, organizations such as airshed zones and watershed councils, which involve industry, municipalities and other stakeholders, have taken on responsibility for various aspects of monitoring. These programs are neither well-integrated nor coordinated to the extent needed to support a world class system. Once the Commission is in place, a careful and deliberate phased approach will be required to achieve the desired objective of a comprehensive and integrated provincial monitoring system. Development of a successful monitoring agency should be an "adaptive, evolutionary process." This suggests that a series of phases is required to implement the proposed system.

6.3 A Phased Approach

Achieving a comprehensive, province-wide environmental monitoring, evaluation and reporting system for air, land, water and biodiversity requires substantial fiscal resources and concerted effort over time to establish the monitoring Commission and implement the system. Coordination with existing monitoring organizations is needed to ensure a timely, efficient and cost-effective transition to a provincial integrated system for all environmental components.

As a first step to developing a provincial monitoring, evaluation and reporting system, a complete inventory should be conducted of all the bodies and agencies involved in monitoring. This would include a review of current financial requirements and roles and responsibilities and relevant policy and monitoring initiatives now underway. Evaluation of current commitments and monitoring activities by governments, industries and other organizations should form the foundation upon which the new system is designed.

The new Commission should then develop a plan to determine if existing environmental monitoring programs could be integrated to improve efficiency. Development of this plan will require consultation and liaison with multiple government departments and agencies, industrial operators, regional monitoring programs and organizations involved in baseline monitoring and effects monitoring across the province.

The next phase would be to develop and implement environmental monitoring activities that respond to the needs of each geographic region, following the boundaries described in the Land-use Framework. Implementing a coordinated province-wide monitoring program could require policy and legislative initiatives throughout government, and high level coordination and cooperation involving industries and the university and research communities.

Systems to support data management, interpretation and communication to the public and other stakeholders will be needed once the Commission is operating. Processes will be needed to ensure that findings from the monitoring programs are communicated to inform governments in their capacity as policy makers, regulators and resource managers. Seamless data and research management systems should facilitate the development of better and more effective environmental policy and regulation. While planning such information management systems should be an integral part of earlier implementation phases, the roll-out of a data and information portal should signal publicly that a mature environmental monitoring, evaluation and reporting system is in place.

Recommendation 19:

Assessment of Existing Environmental Monitoring Activities

The Panel recommends that the interim Board of the Commission complete, as an early priority, an assessment of all existing monitoring programs in Alberta with a view to developing a strategy for the integration of existing monitoring programs into the work of the Commission, as appropriate.

Recommendation 20:

Phased Implementation

The Panel recommends that the new monitoring, evaluation and reporting program be implemented first in the Lower Athabasca region, and then implemented in phases throughout the rest of Alberta.

Conclusion

7

Environmental organizations in Alberta and beyond our borders have questioned the environmental management of industrial operations in the Lower Athabasca region. Albertans generally are asking that steps be taken to protect the remarkable environments found in many parts of our province. Alberta's environment is under pressure on many fronts. While oil sands developments have attracted the most attention, other activities are having impacts too, including urban development, acreage developments, transportation systems, intensive agriculture and forestry operations, other energy and industrial developments, tourism and recreation.

National and international scrutiny of the way Alberta manages the environmental impacts of resource development has challenged us to address these issues in a more comprehensive way. The global appetite for energy will not diminish in the near future; Alberta's energy supplies will continue to be in great demand. Protecting our environment and quality of life is not some distant or hypothetical challenge; it is a very real imperative that requires a response ***now***.

Alberta requires credible, comprehensive data and information to more fully understand environmental impacts and make good policy decisions. Environmental monitoring, evaluation and reporting will provide the basis for good environmental management decisions and, in turn, good resource development decisions. Public trust in these decisions is what gives industry its social license to operate and maintains confidence in government.

In the last five months, the Panel has examined a wide array of information and listened to a number of Albertans, many of whom had experience with the current monitoring system. Based on this work, the Panel reached three main conclusions, around which the recommendations in this report have been developed:

- Alberta needs a new environmental monitoring, evaluation and reporting system that focuses on environmental effects monitoring, is grounded in rigorous scientific design and execution, incorporates Traditional Environmental Knowledge, and has a publicly accessible data and information management system.

- Environmental monitoring, evaluation and reporting activities must be organized and integrated across the province and across air, land, water and biodiversity to enable more effective use of funds and ensure a consistent approach.
- The best way to ensure scientific oversight and organization and integration of activities is to establish a permanent, sustainably-funded, arm's length Environmental Monitoring Commission.

The recommendations in this report will establish the foundation for a world class monitoring, evaluation and reporting system that will provide the environmental assurance that Albertans expect. Panel members are optimistic that when the world asks the question, "Can Alberta develop an environmental monitoring, evaluation and reporting system that guides responsible development of its natural resources in a way that anticipates and addresses potential environmental impacts?" the answer will be a resounding "yes."

Glossary

AMBIENT	The environment that surrounds an ecosystem.
ANTHROPOGENIC	Human-induced or caused.
BACKGROUND	The natural environment, not influenced by human activity. In some circumstances background could be used as a baseline.
BASELINE (ENVIRONMENTAL)	An initial set of observations or environmental data used for comparison or as a control against any future trends. It is also important to continuously monitor the state of the natural environment to understand natural variability and change. In addition to historical records to support design of surface water and groundwater systems, much operational management of water systems and flood warning and management needs real-time information on precipitation and surface water levels.
CEO	Chief Executive Officer
COMPLIANCE MONITORING	The monitoring of variables required for regulatory compliance.
CORE MONITORING	Long-term monitoring of well-established variables that are strongly correlated to ecosystem health and function.
CUMULATIVE EFFECTS	Changes in the environment due to the combined effects of past, present and foreseeable human activities.
CUMULATIVE EFFECTS MANAGEMENT	Managing the cumulative effects of development considering all activities in an area and their collective impact on the environment, society and economy when making decisions.
DEVELOPMENT DRIVER	A socio-economic condition or factor that results in increased development and resulting pressures on the environment.

EFFECTS-BASED MONITORING	Monitoring activities undertaken to determine the status or trend of specific environmental attributes or indicators that reflect the current state of the environment.
ENVIRONMENTAL MONITORING SYSTEM	A set of functions that collectively work together to allow standardized and systematic measurement, evaluation and reporting of environmental conditions.
ENVIRONMENTAL PRESSURE	Stresses that human activities place on the environment.
EVALUATION	Analysis and interpretation of data and information to determine nature, processes, causes and implications of environmental conditions
INDICATORS (ENVIRONMENTAL)	Measurable variables that provide information on the state or condition of environmental components.
INVESTIGATIVE MONITORING	Short-term monitoring of selected variables for specific purposes (e. g. test a scientific hypothesis).
LIMITS	A condition beyond which the risk of adverse effects is considered unacceptable. It may also be applied to effluents and air emissions, where it refers to legally enforceable contaminant release limits.
TRIGGERS	A condition which, if exceeded, results in some action being taken.
MANAGEMENT FRAMEWORK (ENVIRONMENTAL)	Management frameworks identify desired regional objectives, limits and triggers for key indicators, as well as approaches and actions to achieve objectives. They set a foundation for ongoing monitoring, evaluation, and reporting including how to communicate the results to Albertans.
MONITORING	A scientifically designed system of long-term, standardized measurements and systematic observations to assist in timely decision making, ensure accountability and provide the basis for evaluation and learning. This report focuses on baseline, compliance and effects monitoring.
OUTCOME (ENVIRONMENTAL)	A qualitative statement on the preferred condition of an environmental component.

PERFORMANCE MEASURE	A measure undertaken to evaluate progress against stated outcomes.
REGIONAL PLAN (LAND-USE FRAMEWORK)	A provincial planning tool sanctioned under the *Alberta Land Stewardship Act*. There will be seven Regional Plans developed for Alberta, plus separate plans for the Calgary and Edmonton regions.
RELEVANT DATA	Data gathered specifically to address monitoring objectives, allow clear communication with the public on the state of the environment and support decision-making.
REPORTING	Documenting the results of environmental indicator or condition evaluation and performance of management actions, and presenting these results to appropriate audiences at specified times.
RESEARCH	Systematic, science-based study of empirical data used to test hypotheses.
SCIENCE	The study of the physical and natural world, especially by using systematic observation and experiment. More specifically within the context of environmental monitoring, it encompasses the use of investigative, analytical and experimental methods to measure, assess, interpret, predict, and respond to changes in environmental parameters and processes.
SCIENTIFIC OVERSIGHT	Supervision based on recognized scientific standards and principles.
WORLD CLASS	A scientifically credible and trusted monitoring and reporting system that meets or exceeds international benchmarks and is optimally suited to address Alberta's needs.

Acronyms and Abbreviations

AARD	Alberta Agriculture and Rural Development
ABMI	Alberta Biodiversity Monitoring Institute
AE	Alberta Energy
AENV	Alberta Environment
AET	Alberta Advanced Education and Technology
AFE	Alberta Finance and Enterprise
AHW	Alberta Health and Wellness
ALSA	Alberta Land Stewardship Act
ARIA	Alberta Research and Innovation Authority
ASRD	Alberta Sustainable Resource Development
CAPP	Canadian Association of Petroleum Producers
CEM	Cumulative Effects Management
CEMA	Cumulative Environmental Management Association
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EMERS	Environmental Monitoring, Evaluation and Reporting System
GOA	Government of Alberta
LAR	Lower Athabasca Region
LICA	Lakeland Industry and Community Association
LUF	Land Use Framework
MER	Monitoring, Evaluation and Reporting
NAPS	National Air Pollution Surveillance
NO_x	Nitrogen Oxides
OSMER	Oil Sands Monitoring and Environmental Reporting
OSRIN	Oil Sands Research and Information Network
PAC	Polycyclic Aromatic Compound
RAMP	Regional Aquatics Monitoring Program
RSC	Royal Society of Canada
SAGD	Steam Assisted Gravity Drainage
SO_x	Sulphur Oxides
WBEA	Wood Buffalo Environmental Association
WMDRC	Water Monitoring Data Review Committee

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Appendix A: Panel Members' Biographies and Panel Terms of Reference

DR. JOSEPH DOUCET is an energy policy economist in the Alberta School of Business at the University of Alberta. He leads a specialized natural resources, energy and environment MBA program and the Centre for Applied Business Research in Energy and the Environment.

DR. WARREN KINDZIERSKI is a professor at the University of Alberta's School of Public Health. He is the former head of chemical risk assessment for Alberta Health and Wellness and is an expert in air quality and health impact assessment.

MR. HAL KVISLE has more than 30 years of leadership experience, and is the former president and CEO of TransCanada Corporation. He is a board member of the Bank of Montreal, Talisman Energy and ARC Resources and serves as vice-chair of the Nature Conservancy of Canada.

DR. ANDREW MIALL is a professor of geology at the University of Toronto, specializing in the study of sedimentary basins, with a broader interest in energy and climate change issues. He is a former President of the Academy of Science, Royal Society of Canada.

MR. DAVID PRYCE is vice president of operations for the Canadian Association of Petroleum Producers. He is also a member of the Alberta Biodiversity Monitoring Institute board of directors and the Alberta Water Research Institute Management Advisory Board.

DR. JOSEPH RASMUSSEN is professor of biological sciences at the University of Lethbridge and Canada Research Council Chair in aquatic ecosystems. His research includes impacts of heavy metals and mining practices.

DR. GREGORY TAYLOR is a professor of biological science and dean of science at the University of Alberta. His research focus includes how plants tolerate stresses such as metal toxicity and nutrient deficiency.

DR. HOWARD TENNANT is the former president and vice-chancellor of the University of Lethbridge, and has served on several public and private sector boards including three terms on the governing board of the National Research Council.

DR. RON WALLACE is a respected scientist and environmental consultant with experience in environmental research and oil sands mining. He has managed major projects, including the Alberta Acid Deposition Research Program and the Alberta Southwest Medical Diagnostic Review Program.

DR. HOWARD WHEATER is a world expert in hydrological science and sustainable water resource management, with extensive international experience studying and advising on flood, water resources and water quality issues. He is a Fellow of the Royal Academy of Engineering London and the American Geophysical Union. He moved from Imperial College London in 2010 to take up the post of Canada Excellence Research Chair and Director of the Global Institute for Water Security at the University of Saskatchewan.

DR. DAVID WILLIAMS is a respected environmental consultant with 35 years of experience. He specializes in human health and environmental risk assessment and in the development of regulatory standards and guidelines.

Alberta Environmental Monitoring Panel Terms of Reference

Purpose

The purpose of the Environmental Monitoring Panel is to provide recommendations to the Minister of Environment on a framework and guiding principles for the development, implementation and sustainment of a world class environmental monitoring evaluation and reporting system (EMERS) for the province of Alberta. The first phase of work is to produce an interim report outlining the principles and a framework and structure for this system.

Background/Context

Alberta desires to have a world class environmental monitoring system for the province as a whole. Alberta's Lower Athabasca River basin presents an opportunity to pilot and deliver a world class EMERS that can ultimately be adapted to the rest of the province. Developing the EMERS is also an opportunity for the Panel to address gaps in the current system with a view to improving overall system credibility, quality of information and transparency.

Objective

The panel is tasked with designing the governance, structure, organization and key functions for a world class monitoring, evaluation and reporting system that addresses all environmental media – air, land, water and biodiversity.

The Framework components will include:

- Guiding principles for the overall system. Three preliminary principles are proposed and the Panel may wish to build on or add to these Principles:
  - Credible: the system will produce data and information that is scientifically reliable and verifiable and can be used to support monitoring system management decisions and policy.
  - Transparent and accessible: Data, information and related reports will be publicly available, relevant and timely. Governance structures and processes for operating and managing the system will be transparent, understandable and include mechanisms for third-party review.
  - Adaptive: The monitoring system will address causal relationships and have the ability to change in response to data and information generated.
- A governance mechanism, including structures and processes for:
  - The delivery of a science based monitoring program that includes third-party review and validation
  - Management, accountability and operation of the system (including lines of authority, roles and responsibilities, third-party/stakeholder engagement and partnerships).
  - Funding and on-going sustainability of the governance mechanism.
- Guidance on development of the physical monitoring network.
- An information system for collection, management and reporting of data.

Scope

The system design will be informed by the need to ultimately apply the EMERS to all environmental media (air, land, water and biodiversity) at the Provincial scale with the initial focus for the Panel's work being the oil sands region and the lower Athabasca River Basin.

Panel Deliverables

The Panel will deliver a report and recommendations that addresses:

1. The current state of environmental monitoring for lower Athabasca River Basin
2. Principles and objectives of the proposed EMERS
3. Governance for the proposed EMERS including:
   a. Processes to achieve scientific credibility through third party review and validation, including system assurance and validation

b. How data and information will be evaluated to increase credibility, scientific authority, and meet international scientific standards.

c. Authority for and management of the science monitoring program.

d. Options for governance and on-going sustainable funding to deliver a long term EMERS.

e. Overall accountability for the system including roles and responsibilities of stakeholders in the governance process.

4. The physical network requirements for a world class EMERS for the lower Athabasca River basin including technology, equipment and hardware.

5. Gaps analysis and recommendations to achieve desired system objectives.

6. An information system including:

   a. Requirements for a data management system, including system location ownership and control.

   b. How results will be reported and the mechanisms required to report.

7. Recommendations on how the system can be implemented at a provincial scale for all media recognizing regional conditions.

Panel Structure

The Panel will use a Chair/co-chair model.

- The co-chairs will be system thinkers and demonstrate strong leadership skills
- Panel members are recognized experts with international reputations in a range of disciplines including monitoring network design, ecosystem and human health, governance models, data validations, and governance models.

The Panel will engage other expertise as it deems necessary, and will undertake a robust process of engagement with those stakeholders that have an interest in the outcomes of this initiative.

Appendix B:
Policy Context Details

1. Regional Planning, Alberta's Land-use Framework and the Seven Land Use Regions

The Land-Use Framework (LUF), enabled by the *Alberta Land Stewardship Act* (ALSA), sets out an approach to manage public and private lands and natural resources to achieve Alberta's long-term economic, environmental and social goals. The Framework divides the province into seven land use regions, outlined below and illustrated in Figure 6, with a land use plan to be developed for each region. These regions are based on major watersheds, and regional boundaries are aligned to best fit with municipal boundaries and natural regions, as shown in Figure 6. Where issues cross regional boundaries, the need for linkages and compatible treatment will be identified in the relevant plans (Government of Alberta, 2008).

"The regional plans will integrate provincial policies at the regional level; set out regional land-use objectives and provide the context for land-use decision-making within the region; and reflect the uniqueness and priorities of each region" (Government of Alberta, 2008, p. 3). Among other things, "regional planning will integrate economic, environmental and social factors and provide the context for future, more detailed planning. The regional plan will ensure that planning for land use, water and air quality are aligned with each other" (Government of Alberta, 2008, p. 23).

The seven regions are geographically and socio-economically diverse. They include a wide range of resource extraction activities and linear disturbances related to a number of industrial sectors, as well as urban development, extensive and intensive agricultural operations, industrial processing activities and, importantly, wildlife habitat and protected areas.

The provincial process to implement the Land-use Framework will see the eventual development of land use plans for seven regions of Alberta, using a place-based approach and mechanisms for managing cumulative effects. Because the seven land use regions align closely with Alberta's major river basins, the Panel decided to use these same regions as the basis for its work and recommendations. However, in some cases, regions could be aggregated for purposes of environmental monitoring.

The first two plans to be implemented are the Lower Athabasca Regional Plan (LARP) and the South Saskatchewan Regional Plan (SSRP); these two initial plans are in progress with the remaining five plans to be completed by 2012.

Northwest Territories
Lower Peace
Lower Athabasca
Upper Peace
Grande Prairie
Upper Athabasca
Cold Lake
Fort Saskatchewan
EDMONTON
Lloydminster
Leduc
Wetaskawin
North Saskatchewan
Red Deer
Red Deer
Airdrie
Calgary
Brooks
South Saskatchewan
Medicine Hat
Lethbridge
LUF Planning Region
Major Basin
Hay River/Great Slave
Peace/ Slave River
Athabasca River
Beaver River
North Saskatchewan River
South Saskatchewan River
Milk River
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100 50 0 100
Kilometers
Data Provided by Spatial Data Warehouse
Geographic Names provided by Geobase
Made with Natural Earth
Natural Earth
Land-Use Framework Planning Regions & Major Basins
Projection: 10 TM
Datum: NAD 83
Scale: 1:5,750,000
Date: Apr 14/11
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http://www.environment.alberta.ca/ PS 8.5x11 P

FIGURE 6. *Land-Use Framework planning regions and major basins.*

Lower Athabasca Region

The Lower Athabasca Region (LAR) comprises the Regional Municipality of Wood Buffalo, Lac La Biche County and the Municipal District of Bonnyville, including the City of Cold Lake, and covers about 93,260 square kilometres. Oil sands resources are the major economic influence, but agriculture, forestry, minerals, natural gas production, and tourism are also present. For example, sand, gravel, crushed stone, clay and shale deposits are located throughout the region and are important resources to support both industrial development and urban growth. About 40% of the LAR is managed under a Forest Management Agreement with embedded timber quotas and permits under the community timber program. Approximately 5% of the land base is used for agriculture, while tourism occurs mainly on the many natural attractions in the area, including lakes, rivers, forests and natural areas (Government of Alberta, 2011b).

The LAR contains approximately 81% of Alberta's bitumen reserves and much of the Cold Lake oil sands area. Using current technology, about 175 billion barrels of bitumen, or 10% of the entire estimated reserve, can be recovered economically. As oil prices rise, future advancements could lead to development of the full 1.71 trillion barrels of bitumen (Government of Alberta, 2011b).[1] Oil sands investment has increased dramatically over the past two decades, from $490 million in 1991 to a high of over $20 billion in 2008, prior to the global recession (Government of Alberta, 2011b).

The *Draft Lower Athabasca Integrated Regional Plan*, released in April 2011, identifies seven regional outcomes, one of which is optimizing the economic potential of the oil sands resource. However, infrastructure and the availability of a skilled work force are likely to be the main factors that determine the extent and pace of growth in the Lower Athabasca region in the coming years.

Substantial population growth has accompanied this expanding resource development, particularly in the main urban center of Fort McMurray. Two communities north of Fort McMurray—Fort Chipewyan and Fort McKay, which are composed mainly of First Nations and Métis residents—are downstream from the oil sands and have experienced the effects of rapid resource development. Their identity, autonomy and cultural survival are linked to their relationship with the land. Although oil sands industries have provided employment, many aboriginal people rely on hunting, trapping and fishing, and they are concerned about possible contamination of their food and water and about direct personal exposure to emissions. As well, First Nations have constitutionally protected rights, which makes them different from other stakeholders in the region.

[1] See Appendix D for more details on the history of oil sands development in Alberta and the technology changes that have occurred.

The cumulative effects of population and economic growth are increasing pressure on physical and social infrastructure as well as on the air, land, water, and biodiversity in the region. Many of these concerns were mentioned to the Panel during engagement sessions in the region, and impacts have also been described in other recent reports. These reports were variously commissioned by the provincial and federal governments and by independent organizations and all of them have stressed the need for a more extensive, holistic science-based approach to monitoring regional air, land, water and biodiversity.

Upper Athabasca Region

The Upper Athabasca Region encompasses Yellowhead County, Municipal District of Lesser Slave River, Municipal District of Big Lakes, County of Athabasca, Westlock County, Lac St. Anne County, County of Barrhead, Woodland County, Hinton, Edson, and Swan Hills. There is a range of industrial activity in this region including forestry, pulp and paper, waste treatment, conventional oil and gas, sand and gravel operations, pipelines, agriculture, tourism and coal mining. Jasper National Park and other provincial parks and protected areas are also important features. Environmental impacts vary depending on industrial activity.

Lower Peace Region

The Lower Peace Region, located in the northwest corner of Alberta, contains many thriving industrial areas such as the Zama and Hay Lakes area, High Level, Red Earth Creek and Wabasca. The economic base includes forestry activity around High Level, conventional oil and gas in the Rainbow Lake and Zama Lake oil fields and cultivated farmland in the southern region of the Lower Peace. Environmental impacts from these industrial activities typically include land fragmentation; greenhouse gases and other emissions such as SOx and NOx; and various hydrocarbons, metals, pesticide and nutrients that can contaminate soil, groundwater and surface water.

Upper Peace Region

The Upper Peace Region, located south of the Lower Peace Region along the Alberta-British Columbia border, has various industrial sectors in towns such as Peace River, Grande Prairie and Grande Cache. The region surrounding Peace River contains deep oil sands deposits that are developed using *in situ* techniques. South of Peace River to Grande Prairie is primarily cultivated agricultural land. This is mixed with conventional oil and gas production south of Grande Prairie, and east to Fox Creek and west to British Columbia. In the southern area of the Upper Peace region around Grande Cache, coal mining and forestry are additional economic drivers. These industries have a wide variety of environmental impacts on air, groundwater, surface water and biodiversity.

North Saskatchewan Region

The North Saskatchewan Region is a diverse area with many activities that have various socio-economic and environmental impacts. The region extends from the Alberta-Saskatchewan border at Lloydminster in the east, to Banff National Park in the west, encompassing the City of Edmonton. East and south of Edmonton, economic activity is largely driven by agriculture in municipalities such as Camrose, Wetaskiwin and Vegreville; oil and gas activity is also found in the region, as well as the Canadian Forces Base at Wainwright. The area around Fort Saskatchewan, also known as "Alberta's Industrial Heartland," is home to Canada's largest hydrocarbon processing areas as well as world scale petrochemical, fertilizer and advanced industrial material manufacturing plants. West of Edmonton, towards Drayton Valley and Rocky Mountain House, the main economic driver is oil and gas activity. This is the location of Canada's largest and most prolific oilfield, the Pembina Oilfield. The area also has forestry and some agriculture activity. The economic diversity of this region illustrates the magnitude, demand and complexity of environmental monitoring and reporting for the area.

Red Deer Region

The Red Deer Region located in the south-central part of Alberta is entirely within the South Saskatchewan River Basin. The region includes the City of Red Deer, City of Brooks, Towns of Strathmore and Sylvan Lake, the Counties of Rocky View and Mountain View, and roughly 13,000 farming operations. The Red Deer Region has various industrial operations such as oil and gas, petrochemical operations, agriculture and agriculture processing industries, and manufacturing industries such as metal fabrication. These industries have a variety of environmental impacts on surface water, groundwater, biodiversity and air.

South Saskatchewan Region

The South Saskatchewan Region comprises about 12.6% of Alberta's total land area. The landscape ranges from grassland ecosystems to the Rocky Mountains. Today, 45% of Alberta's population lives in the region and the economy is relatively diversified. However, balancing economic growth and ecological health is an increasing challenge in the region. The cumulative impact of human activity is a growing concern, particularly in areas of more ecological importance.

The South Saskatchewan Region is under pressure to maintain multiple uses on the same land base, including grazing, wildlife habitat, recreational use, and industrial and commercial development. The region also has the province's scarcest water supplies but some of the highest water demands, adding to the challenge of cumulative effects management. In fact, the South Saskatchewan is one of the most highly stressed rivers in Canada.

Over decades, the twin factors of population growth and agricultural development have heavily influenced the region. The region has the most intensively developed and productive irrigation network in Canada, and contains most of the confined feedlots in the province. Conventional oil and natural gas production is also prevalent, and tourism and recreation has increased. Mineral mining, forestry and hydroelectric and wind power have also contributed to the region's economic base.

Natural and anthropogenic environmental changes have affected agriculture, forestry, biodiversity, flood control and other natural ecosystem functions. Water quantity and quality are a major focus of monitoring in the region. Flow variability, water use, and drought and flood monitoring are also undertaken. Groundwater quality and supply, climate change and meteorological trends are considered critical components of Alberta's provincial monitoring programs. Air quality monitoring is generally focused in cities or areas with specific point-source industries, as well as around confined feeding operations. Land monitoring is done for many purposes, including soil quality analysis and reclamation.

2. Cumulative Effects Management

Alberta has adopted cumulative effects management (CEM) as the model through which integrated environmental outcomes will be achieved, recognizing that changes in environmental conditions are being driven by multiple stressors that interact across geographical space and time. Environmental monitoring will play a key role by providing accurate and timely information on both the state of environmental conditions and the pressures that affect them. Monitoring data and information will support three key decision points within the CEM system:

- Selection and development of outcomes at provincial, regional, sub-regional and local scales, and their associated indicators, targets and thresholds.
- Selection of management actions and delivery tools to enable achievement of outcomes.
- Assessment of the performance (effectiveness, efficiency and appropriateness) of management actions, system processes and policy.

As part of the regional planning process described in the Land-use Framework, Alberta Environment is leading the development of environmental management frameworks for air, land and water. These frameworks establish regional objectives and require monitoring and evaluation of the status of ambient environmental conditions in relation to specific triggers and limits. They will provide environmental context for management decisions related to existing and future activities on the land base.

When a regional plan is approved, an integrated monitoring and evaluation system will be needed to identify any potential effects in a timely manner and determine if further management actions are required. This system will also need to adapt in response to potential new demands for heightened surveillance or a wider array of environmental indicators. Enabling CEM will be a prominent requirement in the design of Alberta's future monitoring, evaluation and reporting system, as it is a foundation for Alberta's emerging environmental management approach.

3. Regulatory Enhancement

The third element that provided context for the Panel's work was the Regulatory Enhancement Project. This project focused on policy development and policy assurance for upstream oil and gas. The intent was to enable Albertans to realize the full benefits of their oil and gas resources while developing these resources in a responsible manner. The Regulatory Enhancement Task Force found that the current regulatory system is confusing for both project proponents and for members of the public, and that it does not sufficiently encourage innovation or continuous improvement on the part of industry or government. The focus is on approvals, rather than managing risks and achieving the desired results (Regulatory Enhancement Task Force, 2010).

The Task Force identified specific opportunities for improvement and recommended an enhanced Policy Development and Policy Assurance System. Components of the enhanced system would improve integration of natural resource policies and establish a single regulatory body with unified responsibility for upstream oil and gas development activities. This "single regulator" would simplify the system, increase transparency and accountability, improve efficiency and effectiveness, and ensure clear and consistent policy guidance. The Task Force's recommendations are leading to major reorganization of environmental agencies and regulatory structures in Alberta.

Appendix C:
Presentations to the Panel

Listed below are the organizations and individuals who made presentations to the Panel in person or in writing.

- Alberta Agriculture and Rural Development (Tom Goddard)
- Alberta Biodiversity Monitoring Institute (Kirk Andries and Stan Boutin)
- Alberta Capital Airshed Alliance (Kristina Friesen)
- Alberta Fish and Game Association (Andy Boyd)
- Athabasca Chipewyan First Nations, Industry Relations Corporation (Lisa King, Rose Ross, Doreen Somers)
- Bill Loutitt (Métis Nation of Alberta: Region 1)
- City of Edmonton (Mike Mellross)
- Clean Air Strategic Alliance (Norman MacLeod)
- Cumulative Environmental Management Association (Glen Semenchuk)
- Ecological Monitoring Committee for the Lower Athabasca (Calvin Duane, CNRL)
- Fort McKay Sustainability Department (Karla Buffalo and Dan Stuckless; technical consultants, David Spink and Ron Bothe)
- Innoventures Canada (Dr. Grant McVicar and Dr. Dino Zuppa)
- John Beaton (concerned citizen of Fort McMurray area)
- John Malcolm, representing non status Indians from Fort McMurray/Fort McKay
- Lisa Schaldemose (consultant)
- Matthew Dance, M.A. Candidate: "Social computing and air quality monitoring"
- MEG Energy (Simon Geoghegan)
- Métis Settlements General Council (Louis Pawlowich)
- Mikisew Cree First Nation – Government Industry Relations Group (Melody Lepine, Kathleen O'Brien, Matthew Whitehead, Sebastian Fekete)
- NEI Investments
- North Saskatchewan Watershed Alliance (Gordon Thompson)
- Oil Sands Development Group (Chris Fordham, Suncor Energy)

- OSMER Collaborative (Perry Hartswick, IBM and Bruce MacArthur, Tesera Systems)
- OSMER Collaborative (Kim Sturgess, Alberta WaterSMART; Robin Winsor, Cybera Inc.; Peter Williams, Big Green Innovations, IBM)
- Parkland Airshed Management Zone (Kevin Warren)
- Pembina Institute for Appropriate Development (Marc Huot)
- Regional Aquatics Monitoring Program (Chris Fordham of Suncor and Wade Stuart)
- Total Energy (Wendy Brown and Pierre Scherrer)
- Toxics Watch Society (Myles Kitagawa)
- Water Matters (W.F. Donahue, report author)
- Wood Buffalo Environmental Association (Dr. Kevin Percy and Carna MacEachern)

Appendix D:
A Brief History of Industrial Development and Monitoring in the Lower Athabasca Region

Oil sands development in the Lower Athabasca region has a long history, characterized by a blend of entrepreneurship, research and development, technological advances, and changing expectations in environmental oversight and regulation. Reference to the resource was first noted in 1719 in the records of the Hudson's Bay Company, when exposed bitumen was observed oozing from a bank of the Athabasca River by a local Cree.

Phase One

Any pollutants in the surface water system prior to 1967 would have originated naturally. During warm weather the viscosity of the bitumen decreases to the point that liquid crude oozes slowly from the exposed faces of the Athabasca River and its tributaries into the surface waters.

Another potential source of natural pollution is groundwater. Migrating subsurface waters pass through the oil sands at depth, and are eventually discharged at the surface into rivers, lakes and ponds. It might therefore be expected that some components of the bitumen and its associated deposits might have leached into the surface water system.

It is important to establish this background or baseline level of pollution as a basis for comparison to present-day pollution levels. It is to be expected that this natural, pre-development state of the waters could be investigated by analysis of the sediment that was deposited during this phase in lakes, ponds and river bar deposits within the Athabasca system. Whereas the major rivers are dynamic systems within which sediment is constantly remobilized and transported downstream, many lakes and ponds are likely to retain undisturbed sedimentary records going back to the post-glacial period, where careful sampling and analysis could provide essential information on natural background levels of pollution. Similarly, natural groundwater pollution could be investigated by groundwater sampling in areas of the oil sands that have yet to undergo development.

Phase Two

The first commercial activity began in 1967 with the Great Canadian Oil Sands (now Suncor) surface mining and upgrading project. From 1967 to 1990, other projects were launched, including the first large-scale *in situ* project in 1978. *In situ* technology represented a major shift in operations and involved recovering the bitumen "in place" without removing the sand and without the need for tailings ponds. Despite substantial research and development efforts, there was little change in the technology through the 1980s and early 1990s, with low world oil prices and high capital and operating costs making oil sands development an unattractive investment for most companies.

This phase saw the development of major strip mines with surface disruption of the boreal forest, the construction of large tailings ponds, and an increase in air and water pollution from industrial plants. Leakage from tailings ponds into the surface waters may have occurred. Dust from coker plants and from the mining process and from movement of heavy equipment became an issue of concern and a vector for pollutant distribution.

In situ extraction projects began during this phase, but their potential effects on the pollution of subsurface groundwater has yet to be evaluated.

Between 1990 and 2000, technology advanced considerably and oil sands operators put in place a number of innovations to improve operating performance and recovery. At the same time, both the federal and provincial governments implemented tax and royalty regimes to promote oil sands development and also put in place regulatory frameworks to ensure environmental oversight. A major breakthrough for *in situ* recovery was the development of horizontal drilling in the late 1980s and early 1990s, and this technique became the underpinning for the Steam Assisted Gravity Drainage (SAGD) recovery method.

Industry, aided by government and academic research programs, worked to improve the efficiencies of the extraction and processing systems. Major reductions were achieved in the use of water and energy for extraction. However, the most important advance was the process developed by Suncor for the treatment of tailings. In the large tailings ponds it had been expected that the silts and mud would gradually settle, allowing the ponds to be dried out and the land reclaimed. However, in practice settling was observed to be an extremely lengthy process, and it was anticipated that it would take up to 40 years for reclamation to be completed. Given the need to continue to develop large new ponds to accommodate the waste from new surface mines, this meant an enormous increase in the proportion of the land

under continuing disrupted conditions. The new Suncor process appears to bring about a significant improvement in this scenario. By treating the fine tailings with a common wastewater treatment chemical, polyacrylamide, it has been shown that the tailings settle within a few years, and it is now estimated that ponds can undergo reclamation within ten years. This will result in a reduction in the area of ongoing surface disruption of about 75%.

The first tailings pond, Suncor pond #1, built on the banks of the Athabasca River, is at an advanced phase of reclamation. Phase two of oil sands development ended with the introduction of the new settling process, which it is anticipated will be applied to Pond #5 starting in 2011.

Given the improvements in extraction, treatment and processing, and the introduction of new tailings treatment processes, phase two likely represents the critical phase of development in terms of potential pollution levels and the scale of the environmental footprint. Monitoring needs for phase two included evaluation of the effects of the first industrial plant (including possible seepage from the first tailings pond) that was established prior to the development of modern environmental standards and protocols. Efforts to monitor, evaluate, and potentially enhance the temporal evolution of reconstructed landscapes and end pit lakes were also part of phase two.

Phase Three

This phase, which has now commenced and will run for the next several decades, represents the period when surface mining reaches its maximum extent, and during which many of the *in situ* projects begin operation.

Although new mines and tailings ponds will be developed, surface disruption associated with each is expected to be substantially less than during phase two because of improved methods of tailings management.

Although new mines and tailings ponds will be developed, surface disruption associated with each is expected to be substantially less than during phase two because of improved methods of tailings management. Environmental monitoring and adaptive management must improve substantially during this phase. Decision-making procedures and protocols for oil sands development require a major overhaul for phase three, with a move from a project-based management process to a more holistic system that takes into account the cumulative environmental consequences to the entire oil sands development area and the entire course of the Athabasca River system. It also needs to appropriately accommodate concerns raised by First Nations residents and integrate Traditional Environmental Knowledge.

Continued improvements in extraction and processing will be driven by industry imperatives for increased efficiency and by societal demands for improvements in the environmental footprint of oil sands operations. Many applied research projects directed towards these ends are underway in industry research laboratories and at universities, many funded by the National Sciences and Engineering Research Council of Canada, and many funded and coordinated by the Alberta Water Research Institute, typically with corporate partnerships.

Phase Four

As the era of surface mining draws to a close, oil sands operations will become dominated by *in situ* projects. Although *in situ* projects require a large amount of space for surface installations, the depth of surface disruption is substantially less, and these projects require no tailings ponds. Surface reclamation is thus expected to be much more rapid.

Oil sands development is continuing the transition from surface mining to *in situ*. The SAGD process remains the most commonly used *in situ* method, but other processes are being developed and their environmental impacts need to be examined more thoroughly. In terms of monitoring, the effects of *in situ* extraction on the groundwater system have yet to be evaluated. The Government of Alberta continues to implement initiatives to address the strategic and operational aspects of oil sands development, including the establishment of this Panel. Industry is working with both the provincial and federal governments as well as with the scientific community to ensure continuous improvement in its environmental performance.

Appendix E:
Current Monitoring in the Lower Athabasca Region

At present, environmental monitoring in the Lower Athabasca region is undertaken by various agencies and organizations, but is done in an uncoordinated and often disorganized manner.

Industrial compliance monitoring is generally undertaken by industrial operators themselves, with data submitted in paper format and used solely by Alberta Environment for compliance purposes. Compliance data is seldom made available to researchers studying environmental effects.

Alberta Environment conducts environmental monitoring activities in many parts of Alberta, including the Lower Athabasca region. The activities of Alberta Environment in the Lower Athabasca region do not appear to be comprehensive or well-organized.

Environment Canada conducts environmental monitoring programs in many parts of Canada, including the Lower Athabasca region. Environment Canada withdrew from certain joint Alberta-Canada programs some 20 years ago, but has recently been increasing its efforts in the Lower Athabasca region. The Water Quality Monitoring Plan, Phase 1 of March 2011 is Environment Canada's most ambitious undertaking in the Lower Athabasca region in more than a decade.

Air Monitoring

Alberta Environment, Environment Canada, industries, and two multi-stakeholder airshed zones monitor air quality in the Lower Athabasca region. One airshed zone—the Wood Buffalo Environmental Association (WBEA) also gathers land and human exposure information, however its primary focus is monitoring ambient air at 15 continuous and 27 passive stations. The other airshed zone is the Lakeland Industry and Community Association (LICA), which does air and water monitoring in the Cold Lake area in the southeastern part of the region. LICA operates four continuous air monitoring stations and 26 passive sites.

Although not a monitoring agency itself, the Cumulative Environmental Management Association (CEMA) has an Air Working Group to address management of cumulative effects of industrial development in the Regional Municipality of Wood Buffalo. The Working Group develops recommendations for regional air quality and air-related

deposition management. Its focus is on air quality and deposition issues related to emissions associated with industrial development that have the potential to contribute to cumulative effects on air quality, human health, and/or regional ecosystems, including vegetation and wildlife.

Land Monitoring

WBEA is looking at the effects of air emissions on the environment. WBEA's Terrestrial Environmental Effects Monitoring (TEEM) Program was designed to detect, characterize and quantify the impacts of air emissions on terrestrial ecosystems and on traditional land resources. The overall objective of TEEM is to monitor air-related (cause) impacts on natural ecosystems (effects) so stakeholders can make informed decisions. In 2008, WBEA adopted a "Forest Health" approach for detection, quantification of change, and prediction of effect, which uses investigations that more thoroughly test cause and effect relationships among stresses and responses.

CEMA's Sustainable Ecosystems Working Group developed a Management Framework in 2008 to address cumulative effects on terrestrial ecosystems and landscapes in the Regional Municipality of Wood Buffalo, including recommendations for regional and sub-regional land management strategies to achieve environmental, economic and social management goals and measurable environmental objectives. CEMA also has a Reclamation Working Group to produce and maintain guidance documents that provide recommendations and best practices which ensure that reclaimed landscapes within the Athabasca oil sands region meet regulatory requirements, satisfy the needs and values of stakeholders, and are environmentally sustainable.

Water Monitoring

The Regional Aquatics Monitoring Program (RAMP) is the main water monitoring initiative in the Lower Athabasca region. Established in 1997, RAMP's mandate is to determine, evaluate and communicate the state of the aquatic environment and any changes that may result from cumulative resource development within the Regional Municipality of Wood Buffalo. It is an industry-funded, contractor-managed program, governed by a multi-stakeholder steering committee and supported by a technical program committee. While the mandate and objectives of RAMP are laudable, RAMP has been criticized for poorly designed programs, failure to execute according to plan, and failure to publish results. RAMP's funding appears inadequate to meet its complex mandate and objectives. RAMP has been the subject of two scientific

peer reviews in the last seven years (Ayles et al., 2004; RAMP Review Panel, 2011), and Environment Canada (Wrona and di Cenzo, 2011) recently released Phase I of a Water Quality Plan for the Lower Athabasca to address and restructure water monitoring programs in the region.

CEMA's Phase 2 Water Management Framework will seek to manage industrial water withdrawals from the lower Athabasca River while providing protection to the aquatic ecosystem, and maintaining social, economic, and traditional use of the river over the long term. The intent is to finalize the development of a monitoring plan based on the outcomes of the Phase 2 Framework. This includes input of Traditional Environmental Knowledge, assessing values inherent with traditional land use, and completing a monitoring indices workshop. Terms of reference for a CEMA Groundwater Working Group are being developed in cooperation with Alberta Environment, and CEMA has worked with Alberta Environment to set up a Groundwater Monitoring Network in the Regional Municipality of Wood Buffalo.

Biodiversity Monitoring

The Alberta Biodiversity Monitoring Institute (ABMI) measures and reports on the state of land, water and living resources across Alberta. ABMI measures and reports on more than 2,000 species and habitats using information collected from 1,650 sites across the province. The ABMI board of directors includes representatives from government, industry and environmental groups, but operates at arm's length from those entities. ABMI is delivered through the University of Alberta, Alberta Innovates, the Royal Alberta Museum, and the Alberta Conservation Association. In 2010, field operations were concentrated in the Foothills natural region, and the Lower Athabasca and South Saskatchewan Land-use Framework planning regions (ABMI, 2010). Data collected by the ABMI provide information required by a number of provincial and federal statutes and policies.

Appendix F: Overview of Governance and Organizational Alternatives

The Panel considered five options for a new Environmental Monitoring Commission:

1. *Status Quo*
2. Internalization within Alberta Environment
3. Multi-stakeholder Organization
4. Coordinating Environmental Monitoring Organization
5. Comprehensive Environmental Monitoring, Evaluation and Reporting Organization

Option 1: *Status Quo*

The Panel specifically examined the Lower Athabasca region, where monitoring, evaluation and reporting are now being done by more than a dozen entities. The Panel considered that these efforts were generally uncoordinated, disorganized and inefficient, despite the considerable effort and allocation of funds. Analysis by several recent review panels and committees led to the conclusion that some of these activities are wanting. Criticisms focus on the lack of scientific oversight in monitoring, evaluation and reporting; inadequate funding and other resources to do the job required; lack of transparency; and lack of overall coordination and integration.

Regional organizations undertake monitoring in other parts of the province, but the activity and calibre of programs is inconsistent and incomplete across categories of air, land, water and biodiversity. Given the deficiencies identified in the Lower Athabasca region and the challenges of expanding monitoring throughout the province, the Panel concluded that the *status quo* is not a suitable option.

Option 2: Internalization within Alberta Environment

The Panel considered the merits of placing environmental monitoring "in house" as a Government of Alberta program, conducted by Alberta Environment under the supervision of the Minister of Environment. The Panel was of the view that internalization could be made to work with adequate funding, strong department

leadership, enhanced internal capacity and expertise, and a long-term commitment to science-based environmental monitoring. However, the Panel concluded that independence from government and regulators is more likely to create the conditions for success and avoid potential or perceived conflict of interest. While Alberta Environment is responsible for policy and compliance, the recommended Commission would be responsible for broader goals. Thus, internalization within Alberta Environment is not a suitable option for establishing a world class environmental monitoring system for the province.

Option 3: A Multi-Stakeholder Organization

The Panel considered the qualities of a multi-stakeholder organization such as several of those now operating in the Lower Athabasca region. Multi-stakeholder organizations bring many constituents to the table and can operate effectively if their mandate is clearly defined and adequate resources are available. However, the Panel concluded that a multi-stakeholder approach would likely be overwhelmed by the challenges of integrating environmental monitoring, evaluation and reporting in the Lower Athabasca region and across Alberta. The criticisms noted for Option 1 also apply to this option, particularly with respect to the need for scientific oversight and leadership. As well, there is potential for conflict of interest with this option. Notwithstanding the successes of several regional multi-stakeholder organizations, the Panel does not recommend consolidating all Alberta monitoring, evaluation and reporting functions under a single multi-stakeholder organization.

Option 4: A Coordinating Environmental Monitoring Organization

Establishing a coordinated, effective and efficient organization is a high priority if a world class environmental monitoring, evaluation and reporting agency is to be implemented in Alberta. A centralized coordinating body, initially focused on the Lower Athabasca, could ensure overall scientific oversight and transparent funding for regional monitoring, evaluation and reporting activities. Environmental monitoring work could continue to be conducted by existing organizations such as the Wood Buffalo Environmental Association (WBEA), the Regional Aquatics Monitoring Program (RAMP), and the Alberta Biodiversity Monitoring Institute (ABMI). The coordinating agency would receive data and reports from these and other organizations in the region, undertake additional monitoring as necessary, compile and evaluate data and information, and publish a complete and transparent picture of the state of the environment in the Lower Athabasca region. The coordinating

agency could facilitate the involvement of Alberta Environment, Alberta Sustainable Resource Development, the proposed Alberta single energy regulator, Environment Canada and other agencies and departments as required. While there is urgency to improve coordination of monitoring activities, this is merely one aspect of the work that needs to be done. The Panel concluded that a more comprehensive and integrated approach is needed. More than just enhanced coordination will be required to realize the goal of a world class monitoring, evaluation and reporting system. Accordingly, the Panel did not select this option.

Option 5: A Comprehensive Environmental Monitoring, Evaluation and Reporting Organization

The Panel considered the merits of consolidating all environmental monitoring, evaluation and reporting activities, starting with the Lower Athabasca, in a single provincial agency, operating at arm's length from Alberta Environment. Such an agency would have full operational and fiscal capability, including the capacity to conduct research into both environmental monitoring techniques and environmental effects. Various federal agencies could be more fully involved with such a comprehensive agency than would be possible through internalization (Option 2).

A comprehensive, arm's length, centrally-managed organization with strong regional operations has the highest likelihood of delivering world class environmental monitoring, evaluation and reporting. Such an organization is described in detail in the body of this report.

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